

NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody / Assessment Unit: Neosho River and Lower Cottonwood River
Water Quality Impairment: Total Phosphorus

1. INTRODUCTION AND PROBLEM STATEMENT

Subbasin: Neosho Headwaters and Lower Cottonwood

Counties: Lyon and Chase

HUC8: 11070201 **HUC10 (12):** 03 (05)
11070203 04 (03, 04, 05, 06)

Ecoregion: Flint Hills, 28
Central Irregular Plains, Osage Cuestas, 40b

Drainage Area: 203.2 square miles

Main Stem Water Quality Limited Segments:

<u>Station</u>	<u>Main Stem Segment</u>	<u>Tributary</u>
Station SC273	Neosho River (26)	Badger Creek (45)
Station SC274	Cottonwood R (1)	Dry Cr (42) Phenis Cr (30) Moon Cr (31) Beaver Cr (29) Jacob Cr (28)

2008, 2010, 2012, & 2014 303(d) Listings: Kansas Stream segments monitored by stations SC273 and SC274 are cited as impaired by Total Phosphorus (TP) for the Neosho River Basin.

Impaired Use: Expected Aquatic Life, Contact Recreation and Domestic Water Supply

Water Quality Criteria:

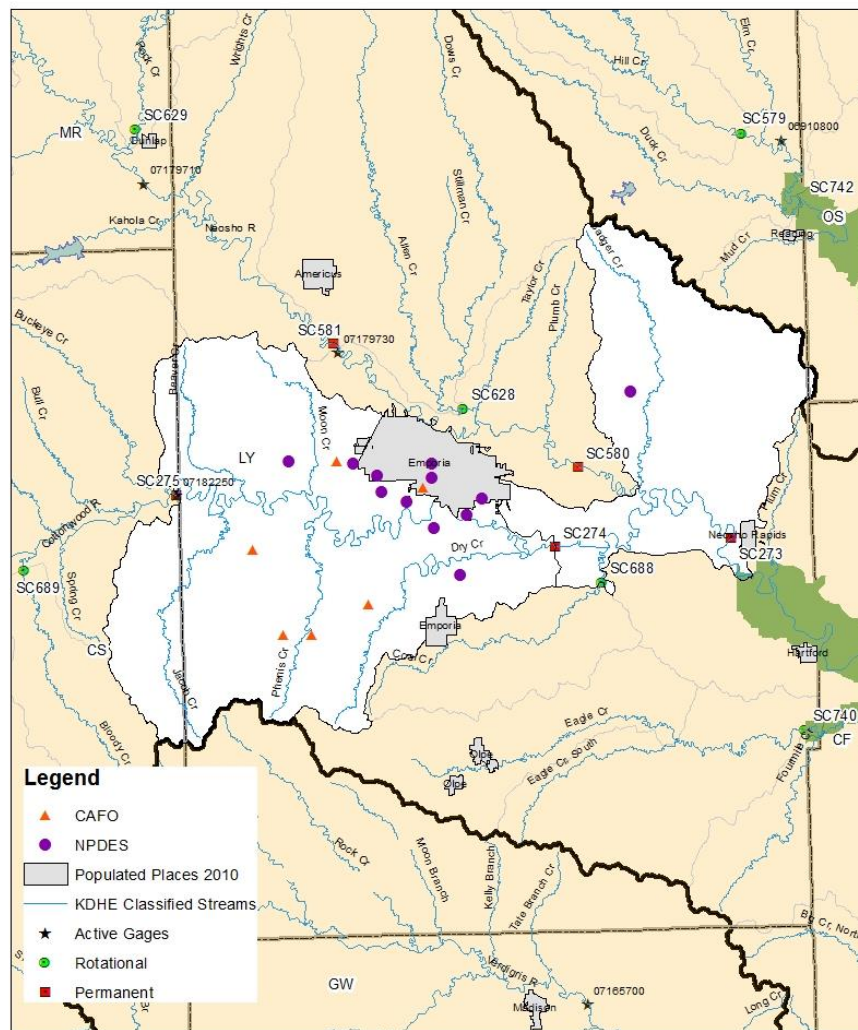
Nutrients – Narrative: The introduction of plant nutrients into surface waters designated for domestic water supply use shall be controlled to prevent interference with the production of drinking water (K.A.R. 28-16-28e(c)(3)(D)).

The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement or aquatic biota or the production of undesirable quantities or kinds of aquatic life (K.A.R. 28-16-28e(c)(2)(A)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation (K.A.R. 28-16-28e(c)(7)(A))

Designated Uses: Special Aquatic Life Use (segments 1, 26 & 28); Expected Aquatic Life Use (segments 29, 30, 31, 42 and 45), ; Primary Contact Recreation B (segment 26); Primary Contact Recreation C (segments 1 and 45), Secondary Contact Recreation b (segments 28, 29, 30, 31, and 42) , Drinking Water Supply (segments 1, 26, 28, 29, 30, 42 and 45); Food Procurement (segments 1, 26, 29, and 45); Groundwater Recharge (segments 1, 26, 28, 29, 30, 31, 42 and 45); Industrial Use (segments 1, 26, 28, 29, 30, 42, 45); Irrigation Use (segments 1, 26, 28, 29, 30, 42, and 45); and Livestock Use (segments 1, 26, 28, 30, 31, 42 and 45).

Figure 1. TMDL Watershed Base Map.



2. CURRENT WATER QUALITY CONDITIONS AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2014-303(d): Phosphorus levels on the Neosho River at SC273 and on the Cottonwood River at SC 274 are consistently high. Excessive nutrients are not being controlled and are thus impairing aquatic life, domestic water supply, and contact recreation.

Stream Monitoring Sites and Period of Record: KDHE monitoring stations SC273 on the Neosho River and SC274 on the Cottonwood River are sampled bimonthly or quarterly during the period of record from 1990-2013.

Hydrology: Long Term Flow condition for the Cottonwood River at SC274 were estimated based on the drainage area ratios between SC274 and USGS gage 07182250 on the Cottonwood River near Plymouth. Long term flow conditions for the Neosho River at SC273 were estimated based on the drainage area ratios between SC273 and USGS gages 07182250 on the Cottonwood River near Plymouth and 07179730 on the Neosho River near Americus. Long term flow conditions for the sampling stations and the USGS gages were based on a period of record from 1990-2013 and are displayed in Table 1. Long term flow conditions for the tributaries in the TMDL watershed were derived from the USGS Scientific Investigations Report 2004-5033 (Perry, 2004) and are displayed in Table 2.

Table 1. Long Term Flow Conditions as calculated from USGS gages 07182250 and 07179730 (1990-2013).

Stream	Drainage Area (square miles)	Mean Flow (cfs)	Percent of Flow Exceedance				
			90% (cfs)	75% (cfs)	50% (cfs)	25% (cfs)	10% (cfs)
Cottonwood River at USGS Gage 07182250	1740	859.6	40	88	239	654	1820
Cottonwood River at SC274	1873.6	925.80	43.08	94.78	257.40	704.36	1960.14
Neosho River at USGS Gage 07179730	622	300.05	15	21	47	188	743.4
Neosho River at SC273	2750	1352.52	72.19	128.07	350.45	1035.06	3188.79

Table 2. Estimated tributary flow values as estimated from USGS (Perry, 2004).

Stream	Drainage Area (square miles)	Mean Flow (cfs)	Percent of Flow Exceedance				
			90% (cfs)	75% (cfs)	50% (cfs)	25% (cfs)	10% (cfs)
Badger Cr.	33.7	21.9	0	0	1.78	7.73	25.8
Dry Cr	22.0	13.2	0	0	1.09	4.54	14.9
Phenis Cr	21.0	12.3	0	0	1.17	4.51	14.3
Moon Cr	17.2	8.71	0	0	0.40	2.25	8.60
Beaver Cr	20.4	9.92	0	0	0.62	2.89	10.20
Jacob Cr	25.6	14.3	0	0	1.57	5.67	17.2
Coal Cr	35.3	20.6	0	0	1.49	6.71	23.1

Flow duration curves over the period of record from 1990-2013 are illustrated for sampling stations SC273 and SC274 are displayed in Figure 2. Annual flow averages for the two stations over the period of record are detailed in Figure 3. Extremely dry years were observed in 1991, 1994, 2000, 2002, 2006, 2011, and 2012. As seen in Figure 4, monthly flow averages indicate the months with the highest flows are March, April, May, June, and July. The months with the highest median flows are March, April, May, and June, as detailed in Figure 5.

Figure 2. Flow duration curve for SC273 and SC274.

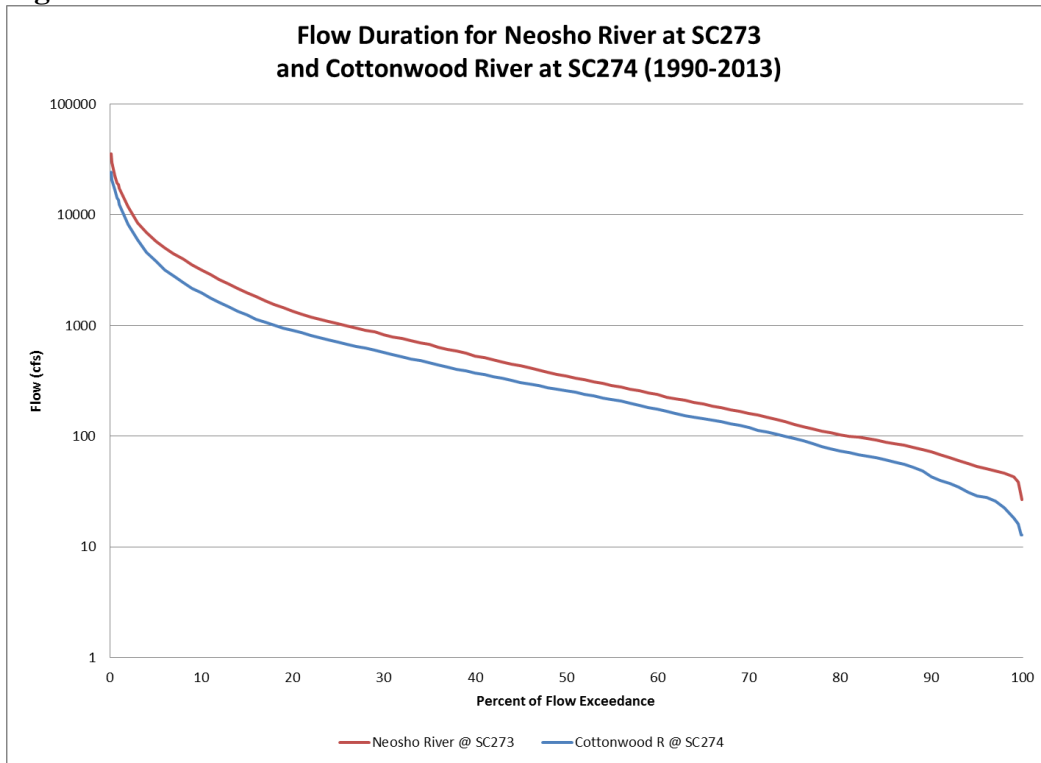


Figure 3. Annual flow averages at SC273 and SC274.

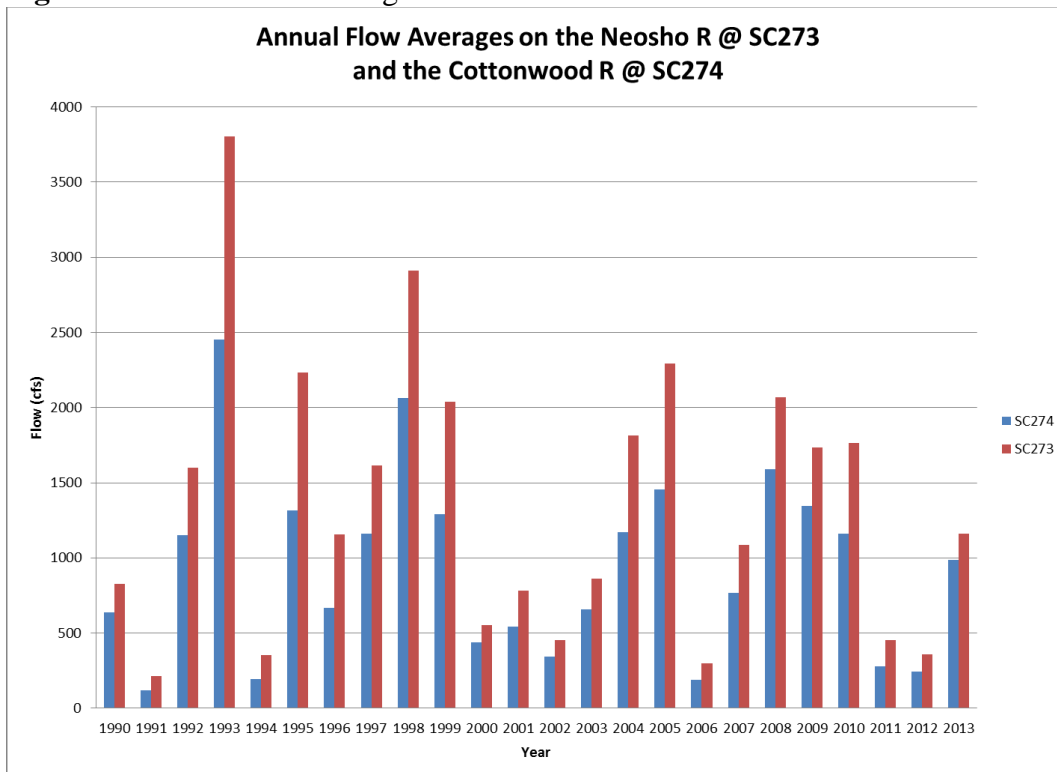


Figure 4. Estimated monthly flow averages at SC273 and SC274.

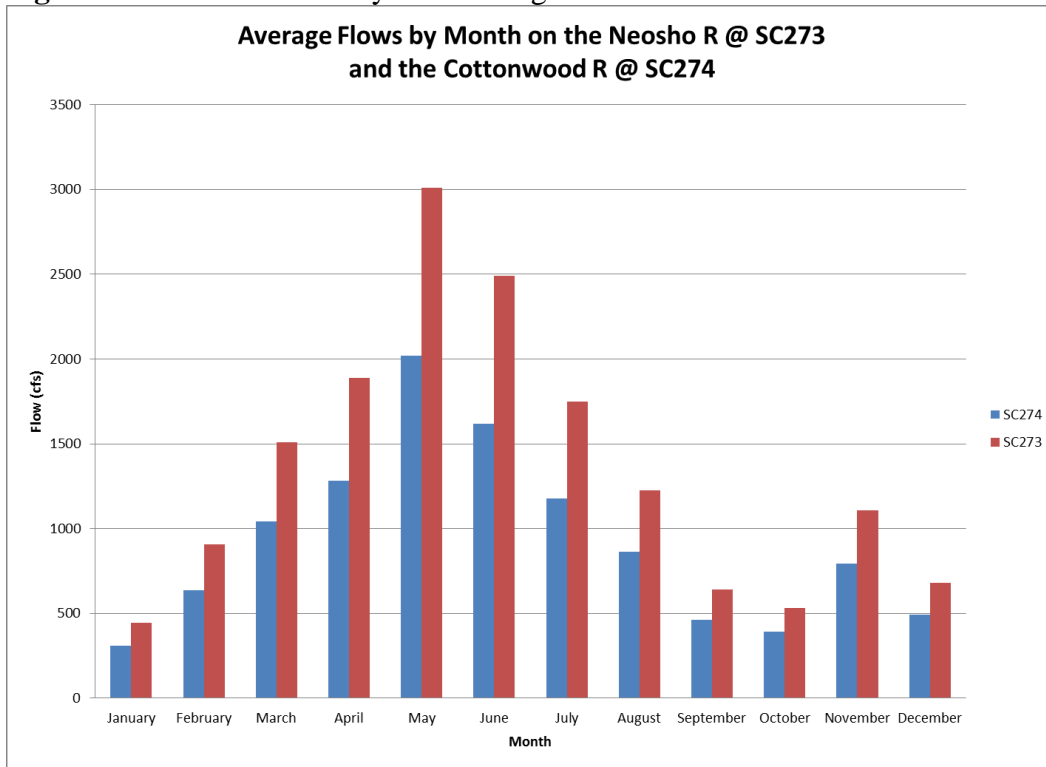
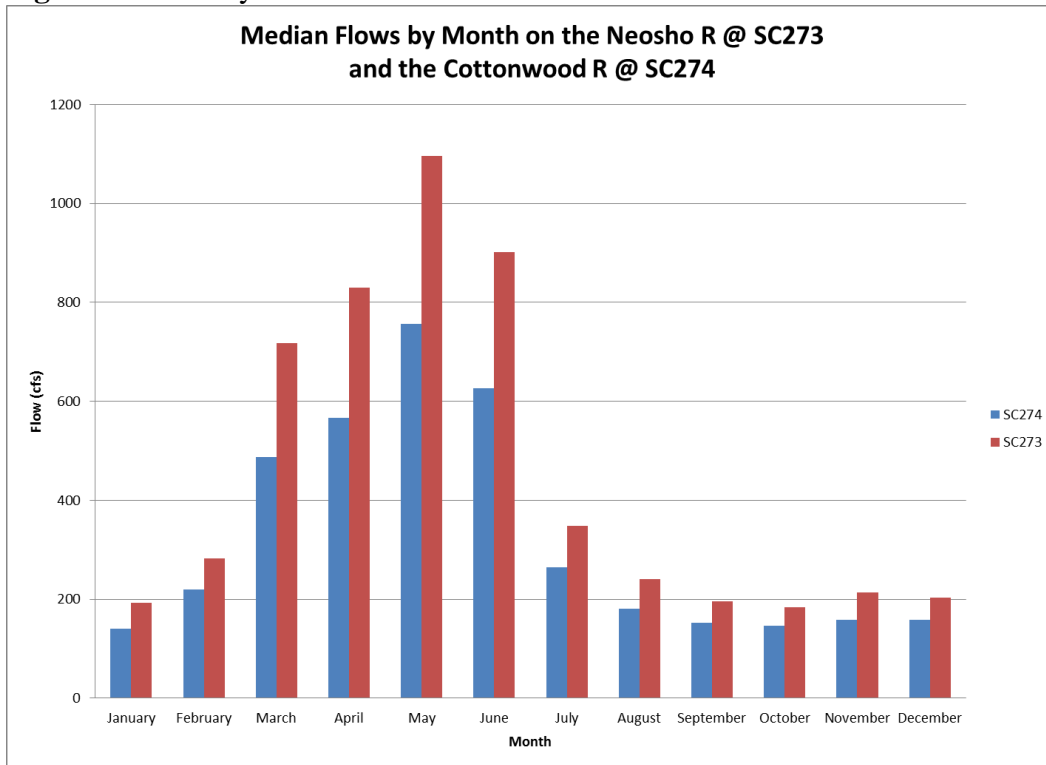


Figure 5. Monthly median flows at SC273 and SC274.



Assessment Season: Seasonal variability has been accounted for in this TMDL. A three season approach was utilized to include: the Spring season consisting of the months of April, May, and June; the Summer-Fall season consisting of the months of July, August, September, and October, and the Winter season that includes January, February, March, November, and December.

Phosphorus Concentrations: The overall Total Phosphorus (TP) concentration average at SC274 on the Cottonwood River is 0.545 mg/L, with a median concentration of 0.396 mg/L. Seasonal TP averages range from a low of 0.436 mg/L in the Spring season to a high of 0.611 mg/L in the Summer-Fall season. Seasonal median concentrations at SC274 are similar between the three seasons, with median concentrations ranging from a low of 0.365 in the Spring to 0.467 mg/L in the Summer-Fall season, to a high of 0.476 mg/L in the Winter.

The overall TP concentration average at SC273 on the Neosho River is 0.438 mg/L. Seasonal TP averages range from a low of 0.381 mg/L in the Spring, to 0.456 mg/L in the Summer-Fall season, and to 0.460 mg/L in the Winter season. Seasonal median concentrations at SC273 are also similar between the three seasons with median concentrations ranging from a low of 0.317 mg/L in the Spring, to 0.342 mg/L in the Summer-Fall, and to a high of 0.365 mg/L in the Winter. Seasonal TP concentrations are further detailed in Figure 6. Tables 3 and 4 further detail the seasonal concentrations respective to the flow condition at SC274 and SC273.

Figure 6. Boxplot of seasonal concentrations at SC273 and SC274.

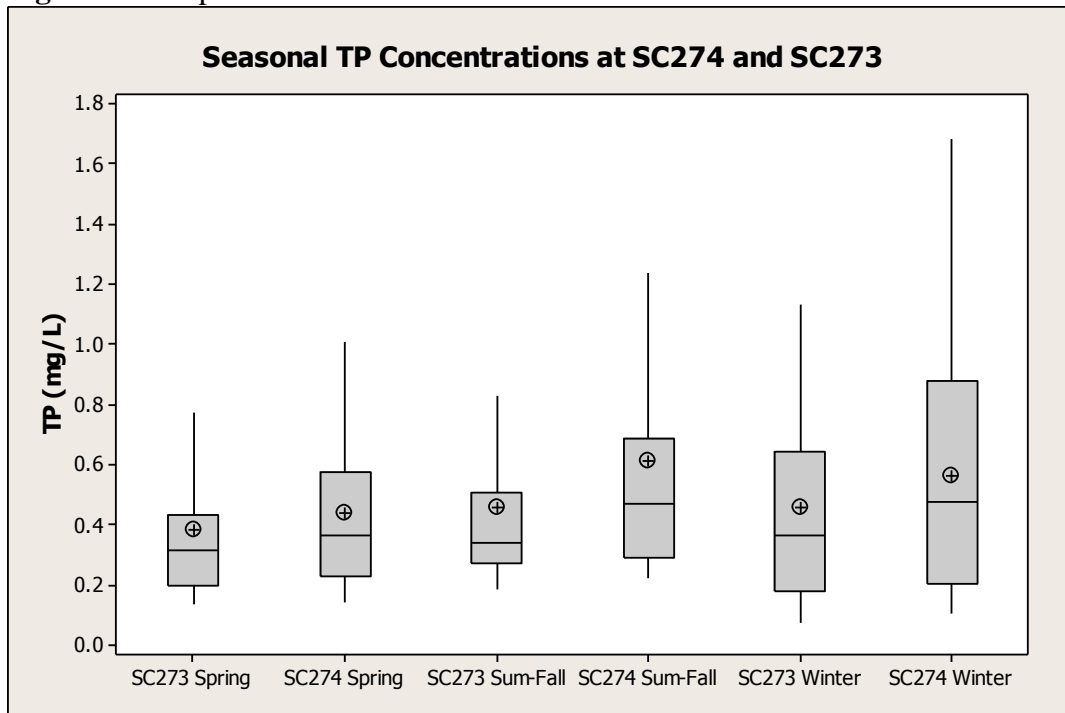
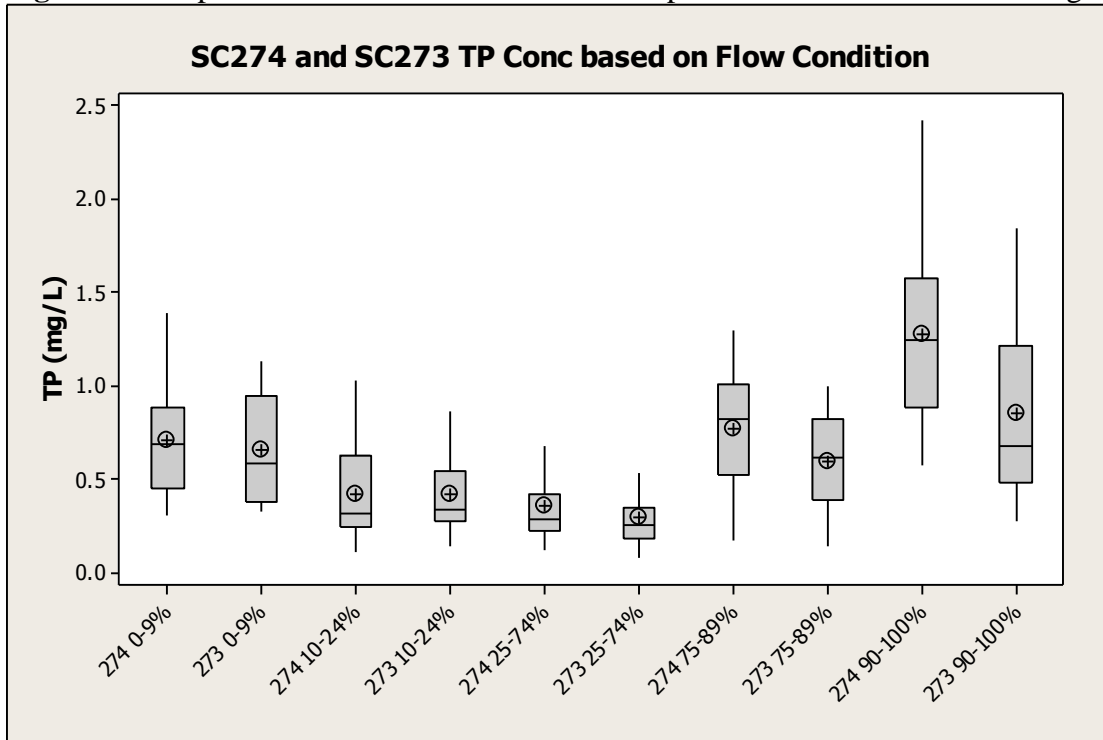


Figure 7. Boxplot of TP concentrations relative to percent of flow exceedance ranges.



Tables 3 and 4 detail the TP averages and medians based on various flow conditions at sampling stations SC274 and SC273. Additionally, Figure 7 details the TP concentrations based on the flow conditions at SC274 and SC273. Phosphorus concentration averages relative to flow are the highest during the low flow condition (90-99% flow exceedance) at SC274 and SC273, with an average of 1.273 mg/L and 0.847 mg/L respectively. TP concentrations are the lowest during the normal flow condition (25-74%) at both stations with a TP average at SC274 of 0.349 mg/L and an average at SC273 of 0.289 mg/L. Median TP concentrations during the low flow (90-100%) condition are 1.241 mg/L at SC274, which is very close to the TP average at this flow condition. The TP median concentration at SC273 are the highest during the low flow condition (90-99%) as well, though the median concentration is below the average TP concentration at SC273 during this flow condition. TP average and median concentrations respectively rise from the normal flow condition to the high flow condition at both stations, indicating an increase of nonpoint source loading in the during runoff conditions.

Table 3. SC274 Cottonwood River TP average and median concentrations relative to the percent of flow exceedance.

% of Flow Exceedance	TP Avg (mg/L)	TP Median (mg/L)
0-9 %	0.707	0.683
10-24%	0.416	0.309
25-74%	0.349	0.284
75-89%	0.766	0.820
90-100%	1.273	1.241
All Samples	0.545	0.396

Table 4. SC273 Neosho River TP average and median concentrations relative to the percent of flow exceedance.

% of Flow Exceedance	TP Avg (mg/L)	TP Median (mg/L)
0-9 %	0.649	0.577
10-24%	0.417	0.329
25-74%	0.289	0.245
75-89%	0.595	0.609
90-100%	0.847	0.671
All Samples	0.438	0.330

Seasonal TP concentrations based on the flow conditions are further detailed in Tables 5 and 6 and Figures 8 and 9. The highest TP concentrations are observed during the low flow conditions during the Summer-Fall season at SC274. The highest observed TP concentrations at SC273 were equally high during the low flow condition during the Winter and the high flow condition during the Summer-Fall season. The higher TP concentrations during the low flow conditions are indicative of wastewater loading, which is predominantly the result of TP loading from the City of Emporia's wastewater treatment plant.

Table 5. SC274 Season Average TP concentrations based on flow conditions.

% of Flow Exceedance	Spring TP Avg (mg/L)	Summer-Fall TP Avg (mg/L)	Winter TP Avg (mg/L)	All Seasons TP Avg (mg/L)
0-9 %	0.657	0.782	0.757	0.707
10-24%	0.399	0.497	0.371	0.416
25-74%	0.326	0.366	0.350	0.349
75-89%	0.915	0.616	0.853	0.766
90-100%	Na	1.37	1.14	1.273
All Average	0.436	0.611	0.560	0.545
All Median	0.365	0.467	0.476	0.396

Table 6. SC273 Seasonal Average TP concentrations based on Flow Conditions

% of Flow Exceedance	Spring TP Avg (mg/L)	Summer-Fall TP Avg (mg/L)	Winter TP Avg (mg/L)	All Seasons TP Avg (mg/L)
0-9 %	0.557	1.01	0.743	0.649
10-24%	0.453	0.449	0.333	0.417
25-74%	0.288	0.299	0.281	0.289
75-89%	0.424	0.532	0.641	0.595
90-100%	na	0.747	1.01	0.847
All Average	0.381	0.456	0.460	0.438
All Median	0.317	0.342	0.365	0.330

Figure 8. Seasonal TP Concentrations relative to flow at SC274

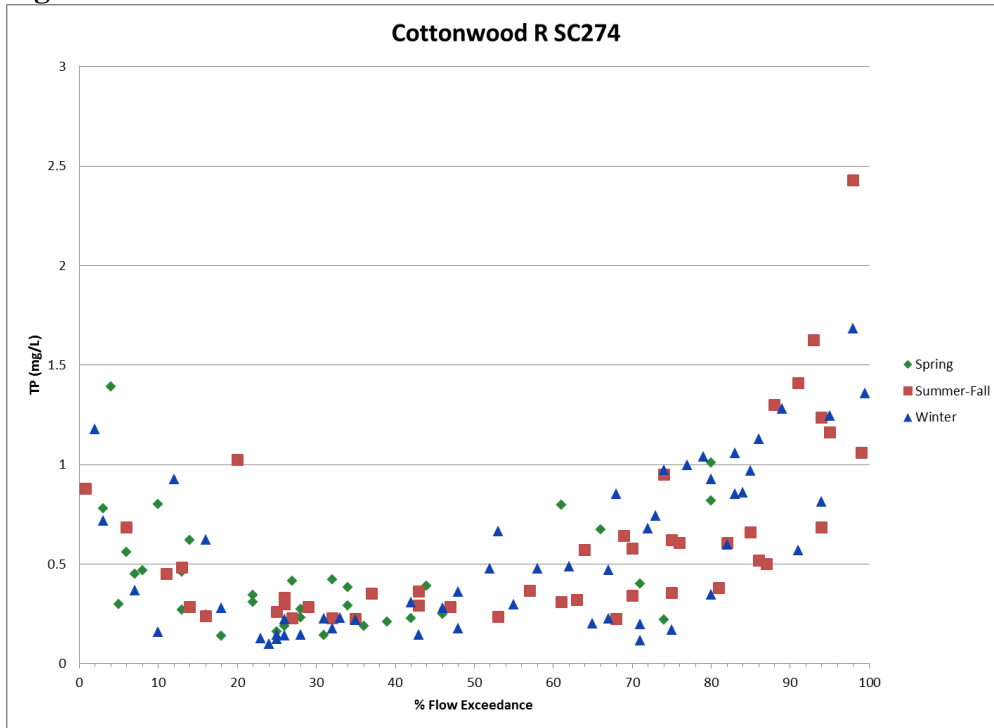
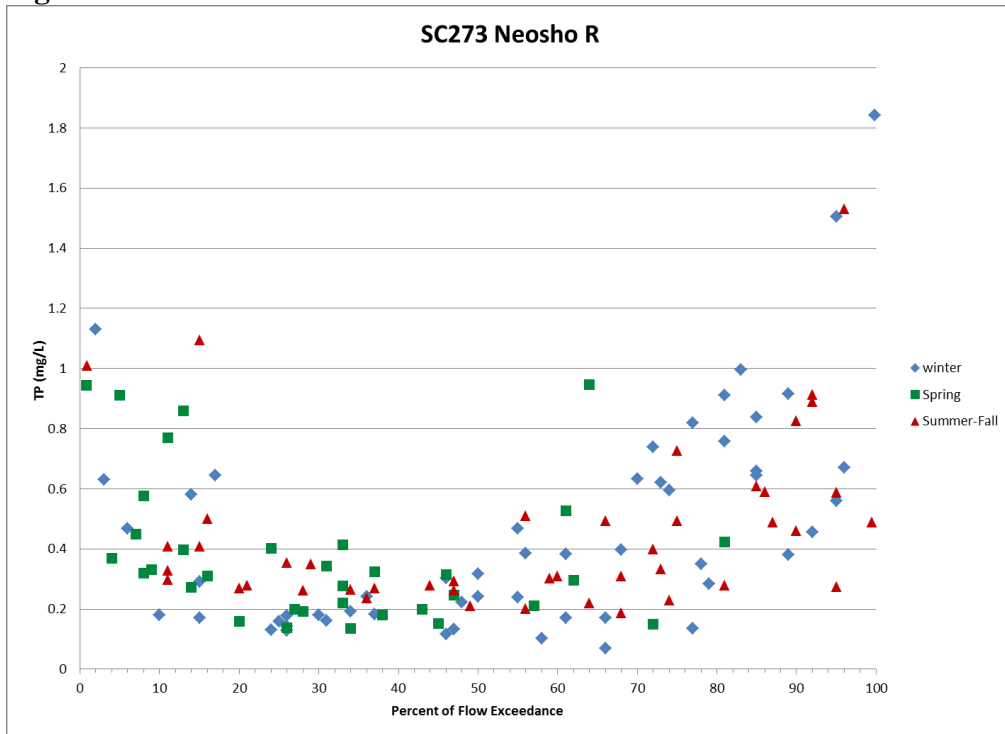


Figure 9. Seasonal TP Concentrations relative to flow at SC273.



There are three mechanisms in place dictating phosphorus concentrations in the lower reaches of the Cottonwood River and on the Neosho River below the confluence with the Cottonwood River. The first factor is the effect of Emporia's wastewater on the downstream hydrology and nutrient content. The second influence is nonpoint sources in proximity to the Cottonwood and Neosho Rivers and their tributaries, both within the TMDL watershed and upstream nonpoint contributions. The final influence is wet weather sources that dominate loading during runoff events, which includes the wet weather impacts of urban stormwater from Emporia and runoff from nonpoint sources in the aftermath of rainfall from areas upstream and within the TMDL watershed.

Monthly average and median TP concentration at SC274 and SC273 are detailed in Figures 10 and 11. These figures detail that higher TP concentrations occur during the months with the lower and higher flows, or during the drier and wetter periods of the year. This further indicates that the high TP concentrations are related to point source influence during the low flow periods and from nonpoint sources during high flow runoff events.

Figure 10. Monthly average and median TP concentrations at SC274.

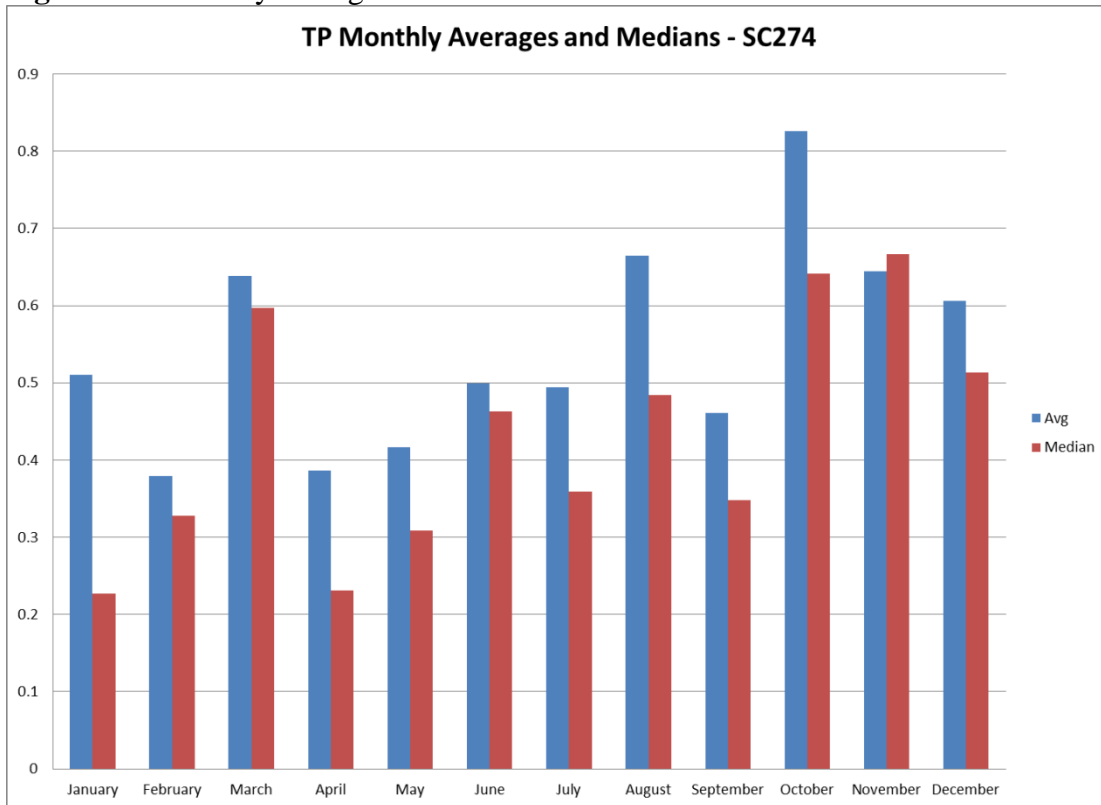
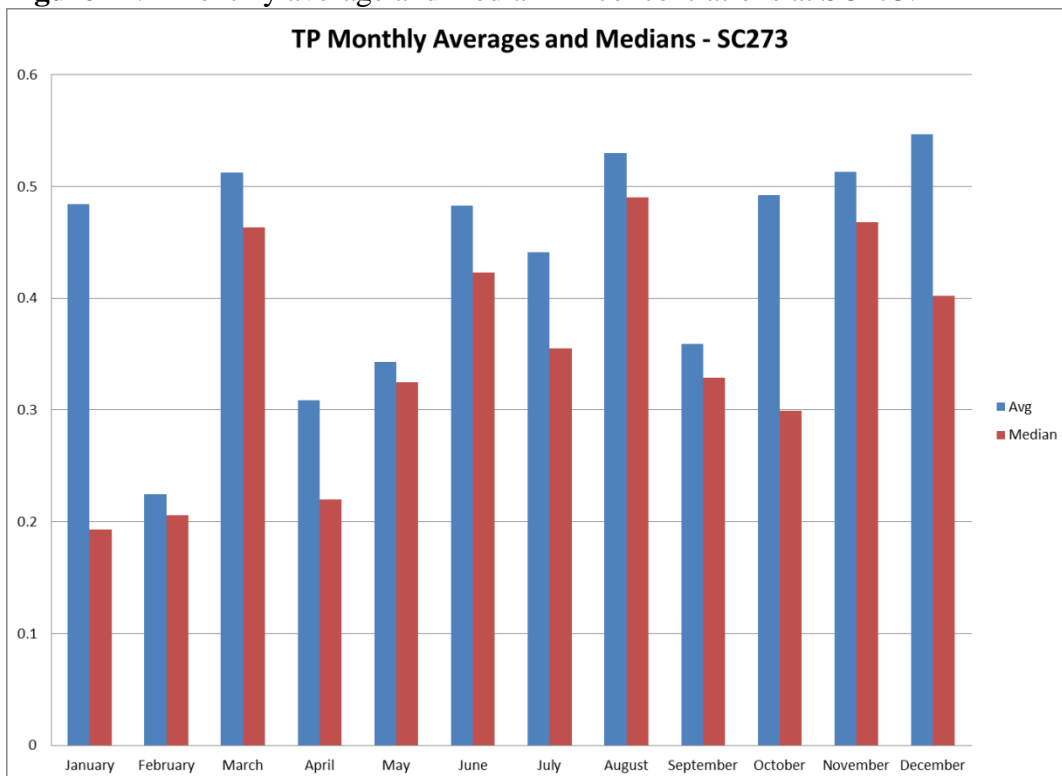


Figure 11. Monthly average and median TP concentrations at SC273.



A TP profile along the Cottonwood River and the Neosho River, which includes the nearest upstream stations and an unimpaired adjoining tributary station is displayed in Figure 12. The sampling stations in the lower Cottonwood watershed that are not impaired include SC688 on Coal Creek and SC275 on the Cottonwood River near Plymouth above Emporia. Additionally, station SC580 on the Neosho River upstream of the confluence with the Cottonwood River is also not impaired. TP averages at these stations range from 0.160 mg/L on Coal Creek at rotational sampling station SC688, to 0.201 mg/L at SC275 on the Cottonwood River, and 0.223 mg/L at SC580 on the Neosho River. The average and median concentrations at these stations are displayed in Table 7.

Table 7. TP average and median concentrations at upstream sampling stations.

Station	TP Avg (mg/L)	TP Median (mg/L)
SC688 Coal Creek near Neosho Rapids (1994-2010)	0.160	0.110
SC275 Cottonwood River near Plymouth(1990-2013)	0.201	0.148
SC580 Neosho River near Emporia (1990-2013)	0.223	0.161

Figure 12. TP profile for select stations above and within the TMDL watershed.

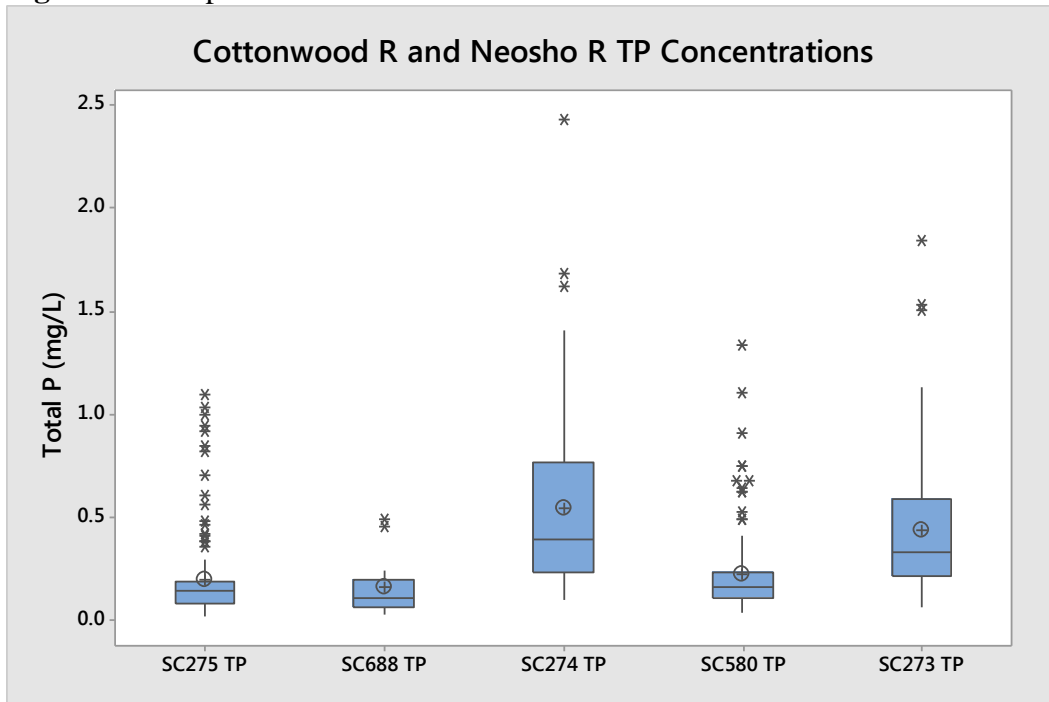
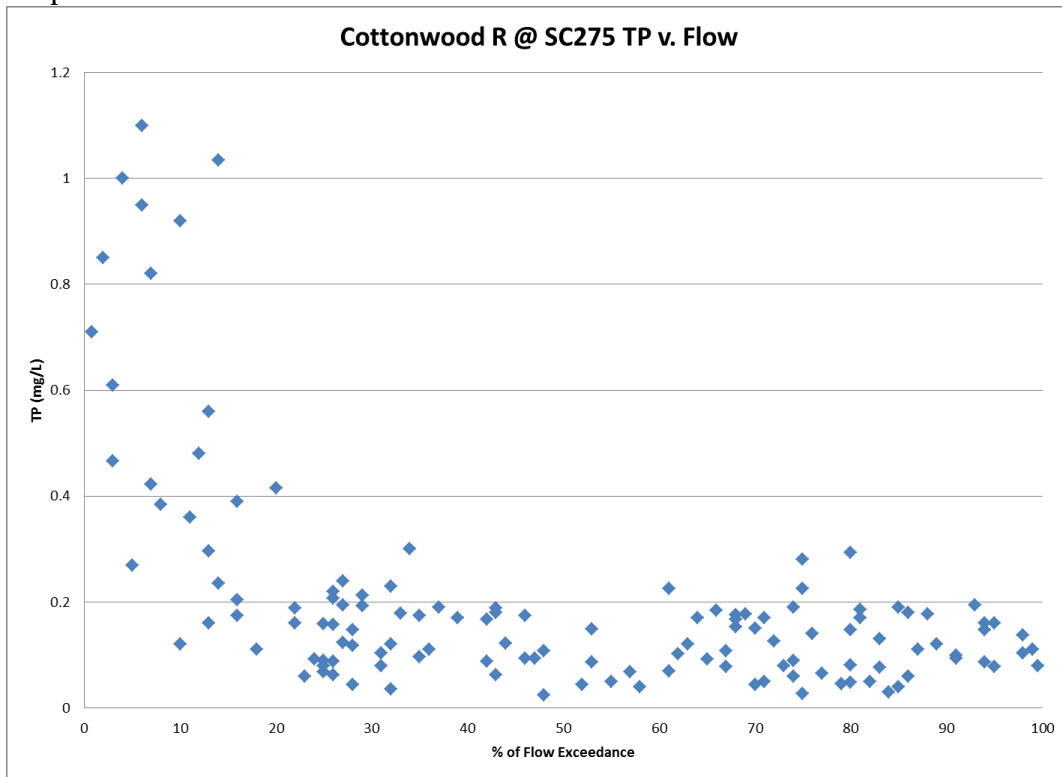


Figure 13 details the TP concentrations at SC275 relative to the percent of flow exceedance. With absence of the point source influence TP concentrations remain similar throughout the flow profile until higher flows are reached, where high flow nonpoint source runoff events occur.

Figure 13. TP concentrations on the Cottonwood River at SC275 near Plymouth above Emporia relative to flow.



There is a strong relationship between TP and TSS concentrations when point source contributions are minimized and nonpoint source loading dominates. This relationship indicates phosphorus is linked to sediment because of the propensity of those solids to adsorb phosphorus. As seen in Figure 14, there is a strong relationship ($R^2 = 0.905$) between TP and TSS concentrations at SC275 on the Cottonwood River above Emporia, which indicates that point sources are not influencing TP concentrations above SC275. Conversely, Figure 15 details the lack of a relationship between TP and TSS concentrations at SC274 on the Cottonwood River below Emporia, which is attributed to significant point source loading from Emporia's WWTP. Point source influence is indicated when high phosphorus concentrations are independent of the sediment or TSS concentrations, which occurs when the point source discharge increases the influence of water quality proportionately as stream flows decrease.

Figure 14. Relationship between TP and TSS on the Cottonwood River near Plymouth above Emporia.

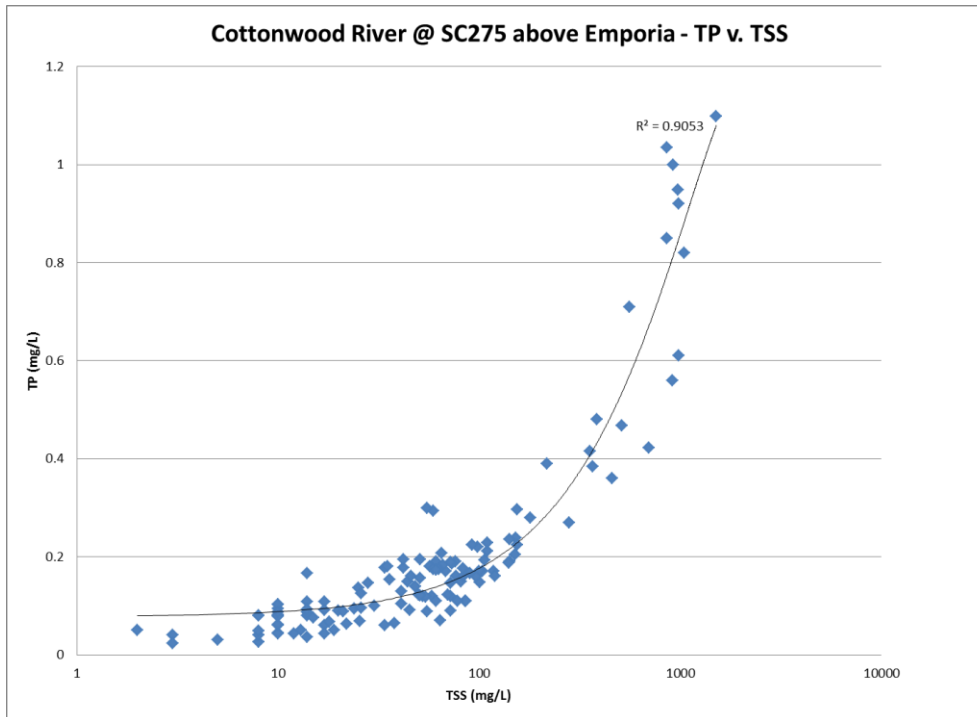
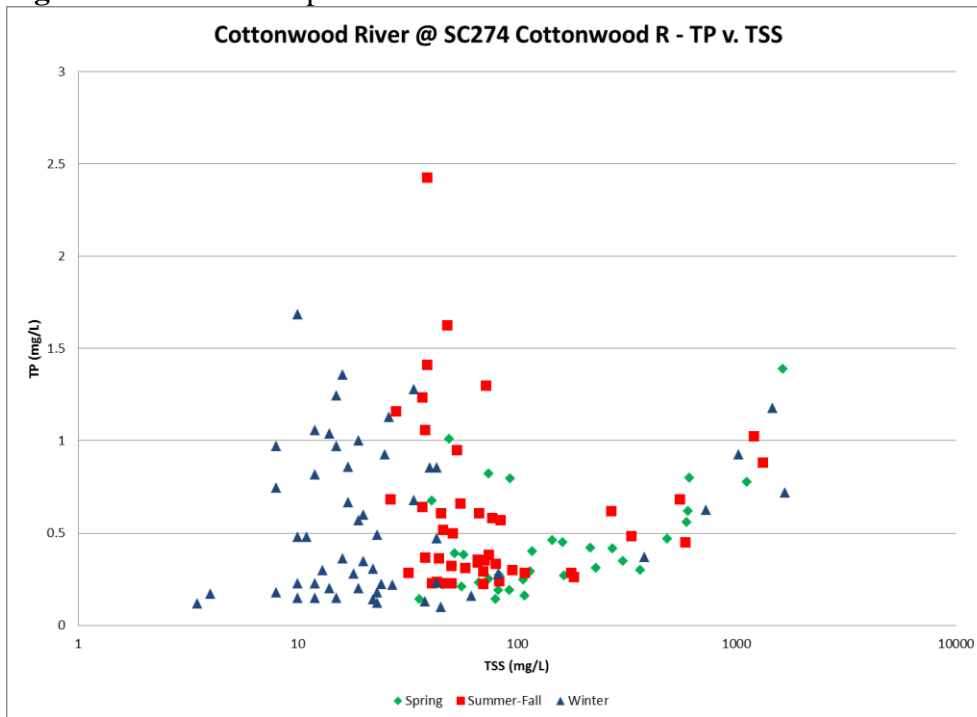


Figure 15. Relationship between TP and TSS on the Cottonwood River below Emporia.



The sampling stations average and median TP concentrations were summarized and compared for the Ecoregion 28 stations. An analyses of TP concentrations within the Ecoregion 28 indicates that the average concentration of the station averages is 0.175 mg/L in Ecoregion 28. Table 8 details the percentiles of the TP concentrations for both the summary of the station averages and station medians. Additionally the Ecoregion 28 station TP data was separated by river basins and evaluated. For station data in the Neosho Basin, the average TP concentration is 0.188 mg/L, the average median concentration is 0.144 mg/L, the 50th percentile median concentration is 0.121 mg/L and the top 25th % of the median concentrations is 0.085 mg/L. The summary of the TP data in Ecoregion 28 by basin is detailed in Table 9.

Table 8. Ecoregion 28 TP Concentration summary

Percentile of Data from Ecoregion 28 Stations	From Station Average TP Concentrations (mg/L)	From Station Median TP Concentrations (mg/L)
25 th Percentile	0.09	0.06
50 th Percentile	0.149	0.103
75 th Percentile	0.222	0.182
90 th Percentile	0.327	0.280
Average	0.175	0.132

Table 9. Ecoregion 28 Stations TP concentration summary by Basin.

Basin	TP Average (mg/L)	TP 50 th % of the Average (mg/L)	TP Avg of Median (mg/L)	TP 50 th % of the Medians (mg/L)	TP 25 th % of the Medians (mg/L)
Kansas Lower Republican	0.177	0.172	0.127	0.109	0.061
Neosho	0.188	0.164	0.144	0.121	0.085
Smoky Hill –Solomon	0.278	0.2	0.237	0.201	0.191
Verdigris	0.082	0.085	0.052	0.050	0.045
Walnut	0.171	0.13	0.138	0.088	0.08

Relationship between Phosphorus and Biological Indicators: The narrative criteria of the Kansas Water Quality Standards are based on indications of the prevailing biological community. Excessive primary productivity may be indicated by extreme swings in dissolved oxygen or pH as the chemical reactions of photosynthesis and respiration alter the ambient levels of oxygen or acid-base balance of a stream. The relationship between pH and stream temperature is illustrated in Figure 16 and 17 for SC274 and SC273. Higher pH values tend to occur during higher photosynthesis periods. Levels of pH exceeded the criterion of 8.5 at SC273 during four sampling events, whereas the criterion was exceeded during two sampling events at SC274. The average pH at SC274 and SC273 is 7.93 and 7.97 respectively, which is within the range of the pH criteria for Kansas waters. Figure 18 and 19 illustrates the relationship between stream pH and the TP concentration at these two stations.

Figure 16. Relationship between pH and temperature in the Cottonwood Rive at SC274.

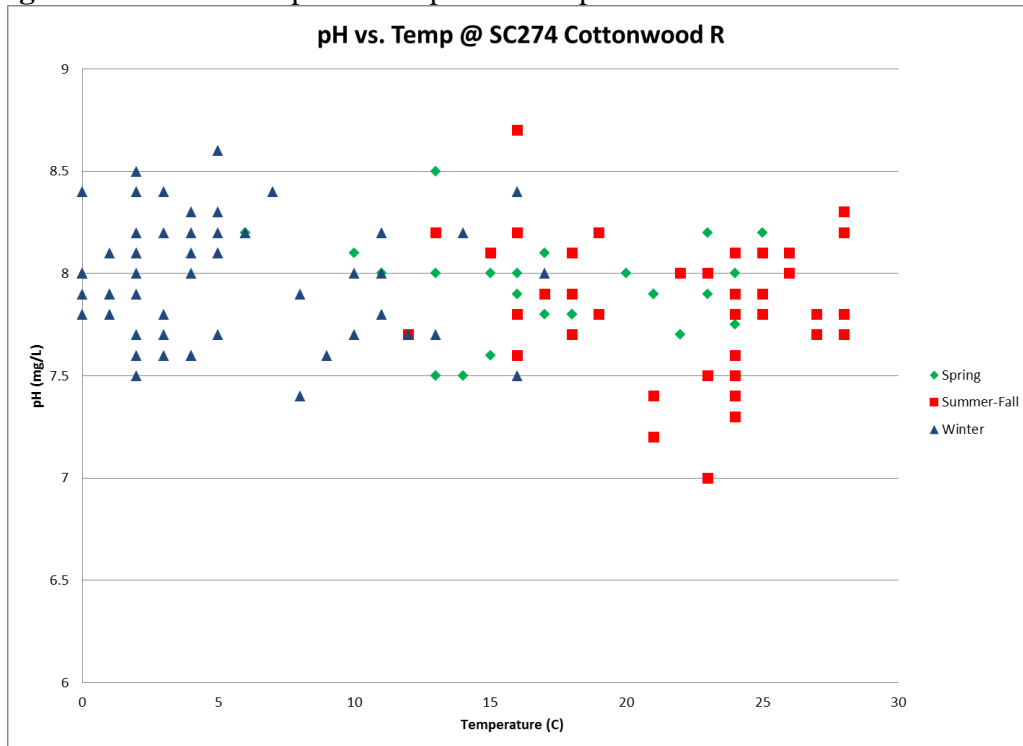


Figure 17. Relationship between pH and temperature in the Neosho River at SC273.

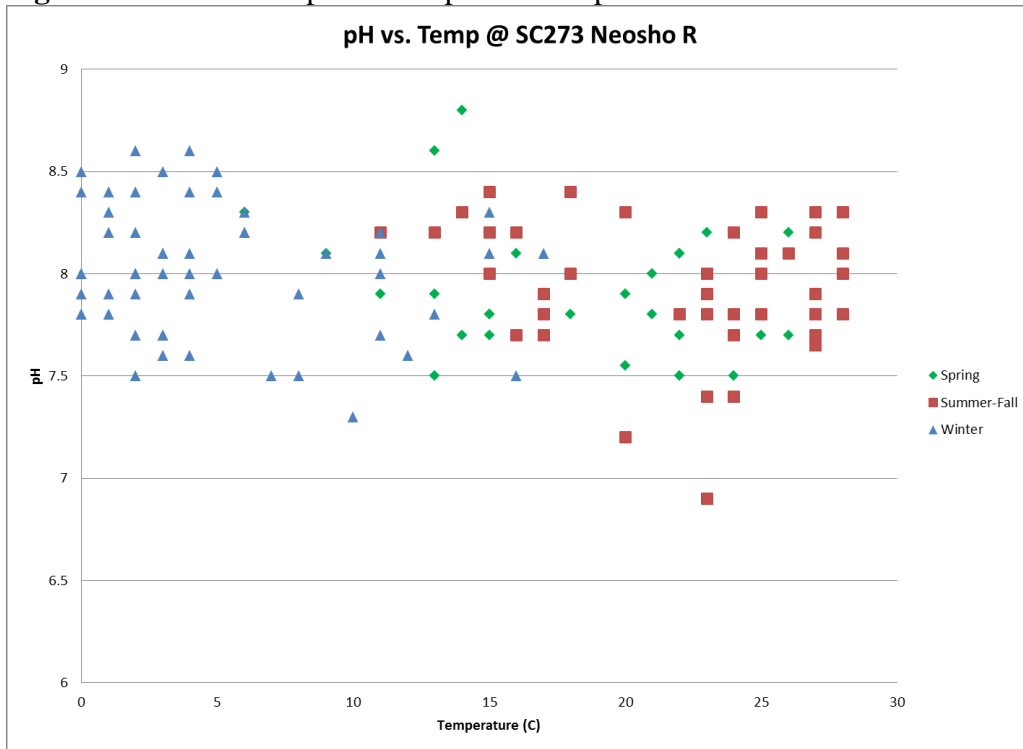


Figure 18. Relationship between pH values and TP concentrations on the Cottonwood River at SC274.

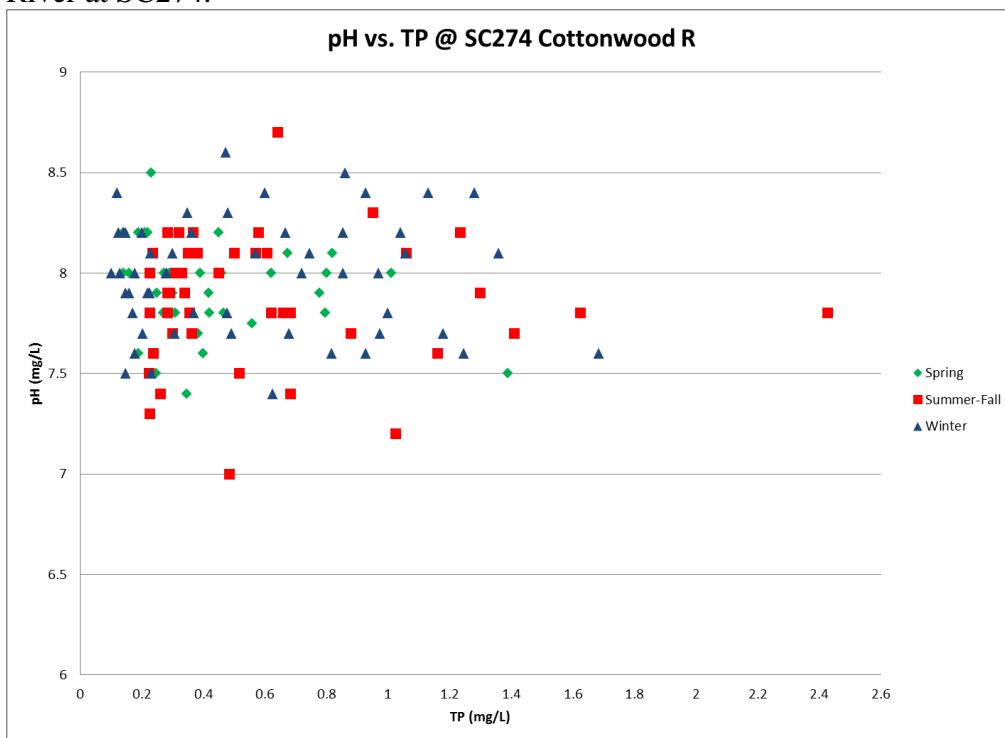
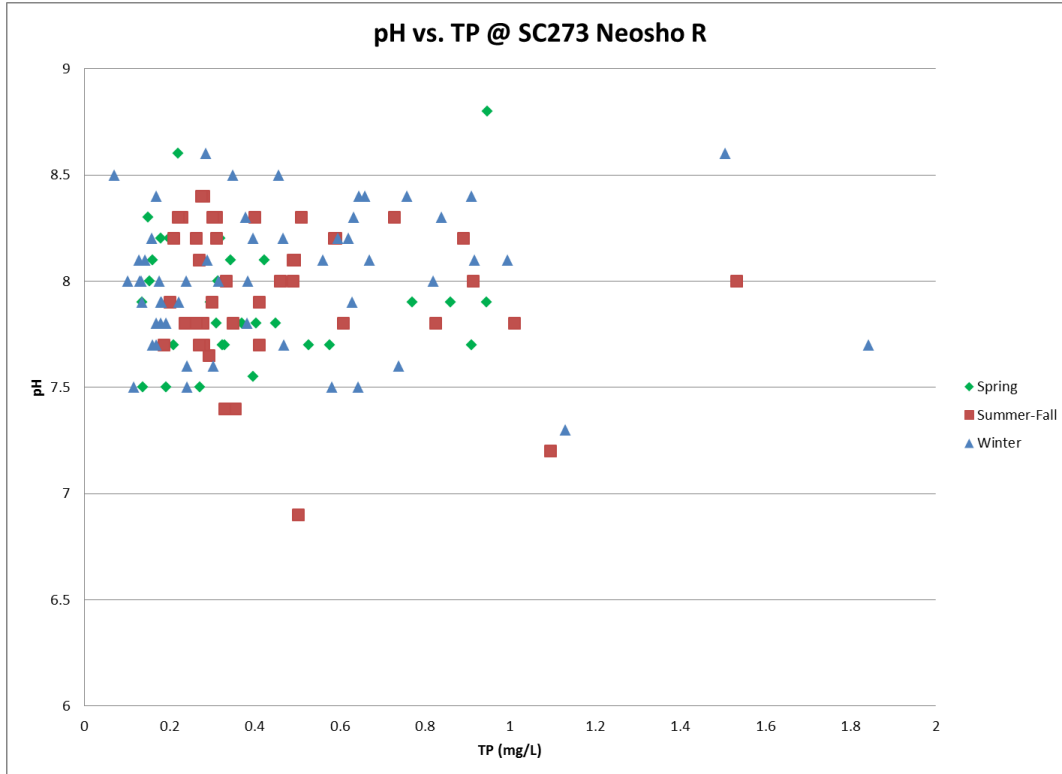


Figure 19. Relationship between pH values and TP concentrations on the Neosho River at SC273.



Current EPA philosophy is predicated on the lowest quartile of stream total phosphorus within an ecoregion as indicative of minimum impact conditions (in absence of reference streams). This generalization is not tied to specific biological conditions, but represents water quality protection policy guiding EPA's administration of clean water programs.

KDHE has sampled sestonic chlorophyll at SC274 since 2003. The average chlorophyll concentration at SC274 is 22.5 $\mu\text{g/l}$ and the median concentration is 17.8 $\mu\text{g/l}$. Despite the influence of the Emporia wastewater on downstream phosphorus levels, chlorophyll levels do not respond linearly to increases in phosphorus as seen in Figure 20a. This may be because of flushing of chlorophyll and nutrients downstream of the monitoring station and a lag in the response. Figure 20b details chlorophyll concentrations relative to the percent of flow exceedance. It is difficult to establish the relationship between the flow and chlorophyll concentrations likely due to the lag in the response to the key factors influencing chlorophyll concentrations. EPA's guidance on nutrient criteria for streams (2000) indicated trophic issues in streams with over 8-15 $\mu\text{g/l}$ sestonic chlorophyll.

Figure 20a. Relationship between chlorophyll and TP at SC274.

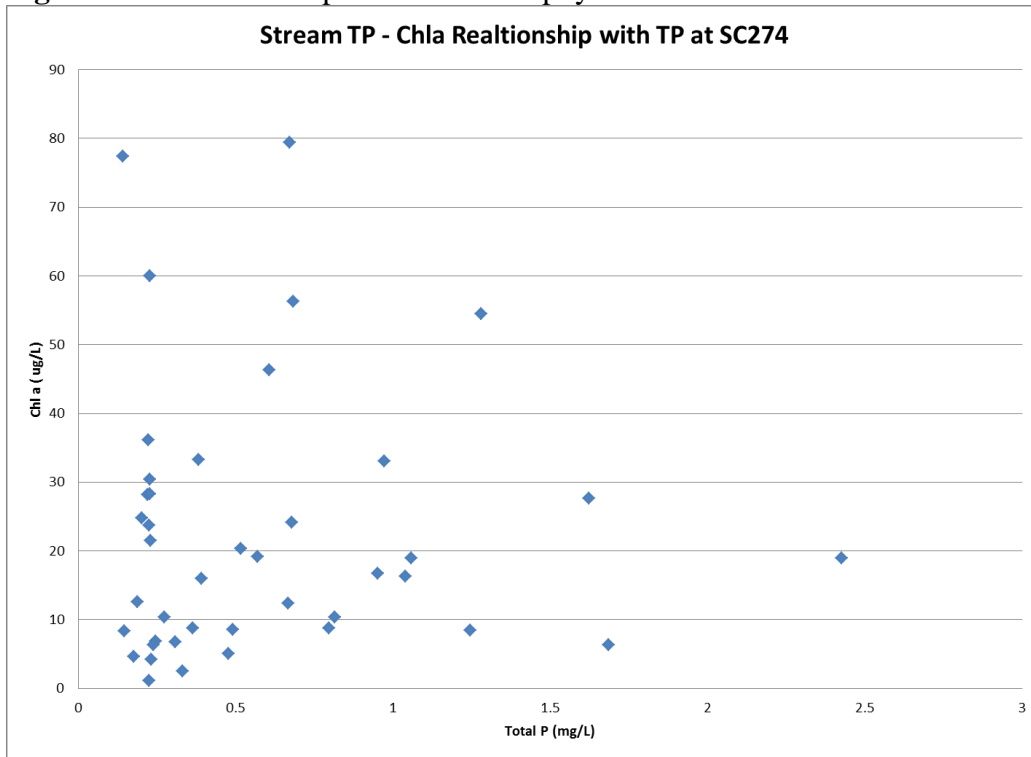


Figure 20b. Relationship between chlorophyll and flow at SC274.

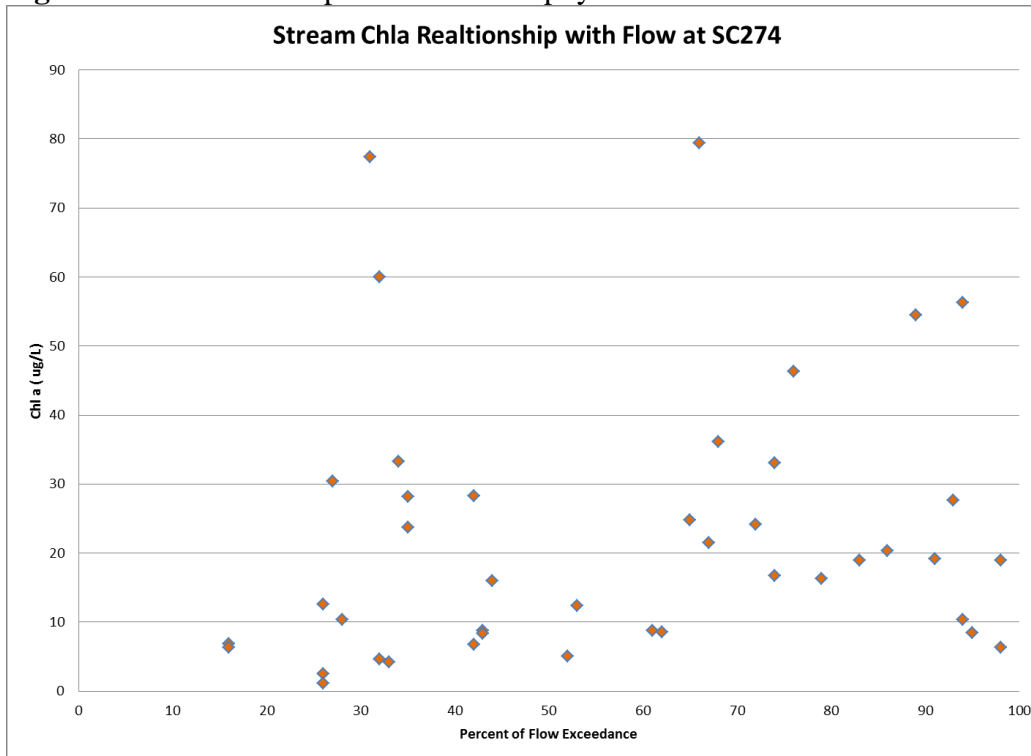
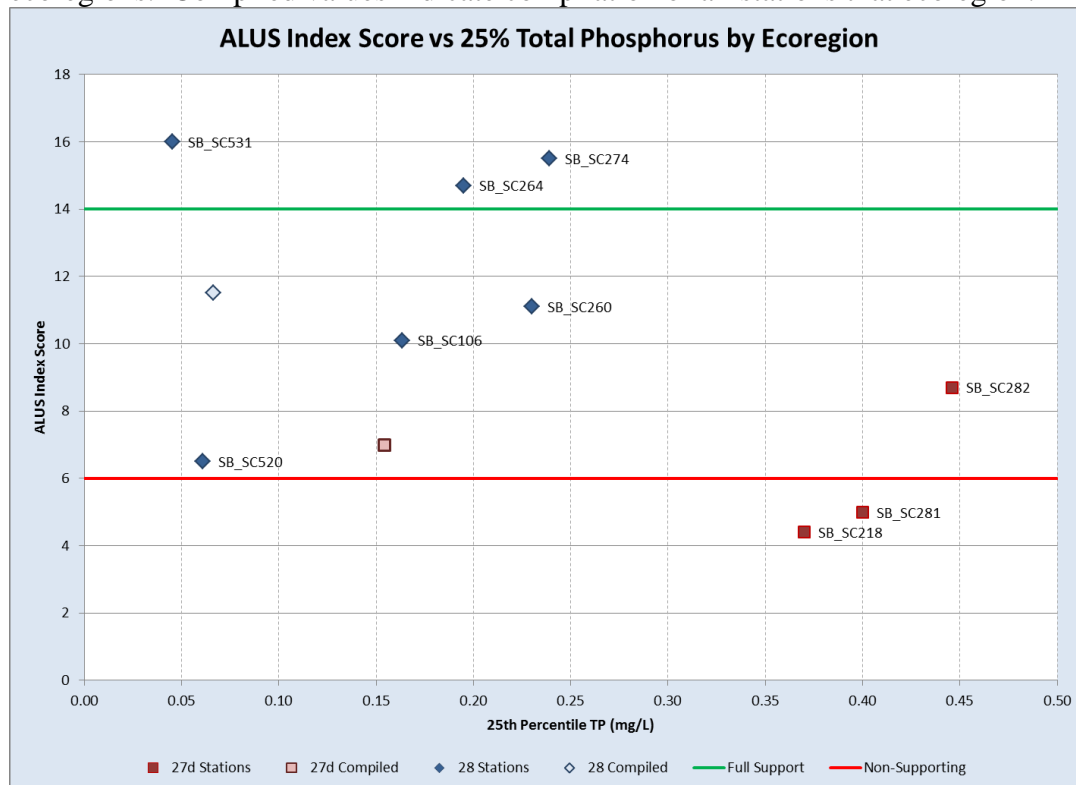


Figure 20c displays the relationship between the lower quartile phosphorus values and ALUS Index scores within the Central Great Plains Wellington-McPherson Lowland (27d) and Flint Hills (28) ecoregions. High ALUS Index scores are indicative of high quality biological communities. Kansas protocol is to delineate the boundaries between full and partial aquatic life support and between partial support and non-support as ALUS Index scores of 14 and 6, respectively. Based on Figure 20b, conditions of full support span phosphorus TP levels of 0.045 to 0.239 mg/L while the condition of partial support have a range of phosphorous concentrations from 0.061 to 0.446 mg/L.

Figure 20c. ALUS Index scores and the lower 25% total phosphorus levels for stations in the Central Great Palins Wellington-McPherson Lowland (27d) and Flint Hills (28) ecoregions. Compiled values indicate compilation of all stations that ecoregion.



Desired Endpoint: The ultimate endpoint of the TMDL will be to achieve the Kansas Water Quality Standards by eliminating any of the impacts to aquatic life, domestic water supply or recreation associated with excessive phosphorus and objectionable amounts of algae as described in the narrative criteria pertaining to nutrients. There are no existing numeric phosphorus criteria currently in Kansas. The current EPA suggested benchmarks for stream TP in the Great Plains Grass and Shrublands ecoregion is 0.023 mg/L TP over the 10-state aggregate of Level IV ecoregions. The EPA reference condition for Ecoregion IV streams in subecoregion 28 (Flint Hills) for the 25th percentile of data is 0.060 mg/L of TP (EPA, 2001).

The contributing area of the TMDL watershed resides in ecoregion 28, the Flint Hills. Comparable analysis of data that is restricted to Kansas Stations in the Flint Hills indicates the lower quartile TP value from the station medians is also 0.060 mg/L, equaling the EPA suggested benchmark. If we further narrow the ecoregion value down to the Neosho Basin, the 25th % of medians is slightly higher at 0.085 mg/L. The median concentration of the means for the stations within ecoregion 28 and the Neosho Basin is 0.164 mg/L.

The Aquatic Life Use Support Index (ALUS Index) and sestonic chlorophyll concentrations will serve to establish if the biological community of the Lower Cottonwood and Neosho River reflects recovery, renewed diversity and minimal disruption by the impacts described in the narrative criteria for nutrient on aquatic life, recreation and domestic water supply. The ALUS Index score consists of five categorizations of biotic conditions:

1. Macroinvertebrate Biotic Index (MBI): A statistical measure that evaluates the effects of nutrients and oxygen demanding substances on macroinvertebrates based on the relative abundance of certain indicator taxa (orders and families).
2. Ephemeroptera, Plecoptera and Trichoptera (EPT) abundance as a percentage of the total abundance of macroinvertebrates.
3. Kansas Biotic Index for Nutrients (KBI-N): Mathematically equivalent to the MBI, however, the tolerance values are species specific and restricted to aquatic insect orders.
4. EPT Percent of Count (EPT % CNT) – The percentage of organisms in a sample consisting of individuals belonging to the EPT orders.
5. Shannon's Evenness (SHN EVN) – A measure of diversity that describes how evenly distributed the numbers of individuals are among the taxa in a sample

Once measured, the metrics detailed above are then assigned a score according to Table 10 and the scores are tallied and a support category assigned according to Table 11.

Table 10. ALUS Index metrics with scoring ranges.

MBI	KBI-N	EPT	EPT % CNT	SHN EVN	Score
<= 4.18	<= 2.52	>= 16	>= 65	>= 0.849	4
4.19-4.38	2.53-2.64	14-15	56-64	0.826-0.848	3
4.39-4.57	2.65-2.75	12-13	48-55	0.802-0.825	2
4.58-4.88	2.76-2.87	10-11	38-47	0.767-0.801	1
>= 4.89	>= 2.88	<= 9	<= 37	<= 0.766	0

Table 11. ALUS Index score range, interpretation of biotic condition, and supporting, partial and no supporting categories.

ALUS Index Score	Biotic Condition	Support Category
17-20	Very Good	Supporting
14-16	Good	
7-13	Fair	Partially Supporting
4-6	Poor	Non-supporting
1-3	Very Poor	

Therefore, the numeric endpoints for this TMDL indicating attainment of water quality standards in the TMDL watershed will be:

1. An ALUS Index score greater than or equal to 14.
2. Sestonic chlorophyll: The concentration of planktonic algae floating in the water column of the stream. EPA (2000) sestonic chlorophyll levels over 8-15 µg/L are problematic. A target value of 5µg/l will be sought for SC274 and SC273.
3. As a long term endpoint, John Redmond Lake should approach a summer time chlorophyll *a* average of 10µg/l or less.

The endpoints have to initially be maintained over three consecutive years to constitute full support of the designated uses of the lower Cottonwood River at SC274 and the Neosho River at SC273. After standards are attained, simultaneous digression of these endpoints more than once every three years, on average, constitutes a resumption of impaired conditions.

The endpoints will be evaluated periodically as phosphorus levels decline over time. This TMDL looks to establish management milestones for phosphorus concentrations that would be the cue to examine the biological conditions of the streams. This TMDL established two milestones to achieve the ultimate endpoint of this TMDL. The first milestone, which applies to all segments within the TMDL watershed, will be a reduction of the median TP concentration at SC274 and SC273 to **0.164 mg/L**, based on the median of the average TP values of sampling stations within ecoregion 28 and the Neosho Basin. The second milestone will be targeted once the first milestone is reached. The second milestone will be a reduction of the TP median at SC274 and SC273 to **0.121 mg/L**, reaching a median equal to that of the best 50% of the stations within the ecoregion 28 and Neosho basin stations. This additionally will result in the second milestone being achieved at the upstream stations SC275 and SC580, since achievement of this milestone will require additional nonpoint source reductions upstream of the TMDL watershed. Table 12 details the reduction of the current TP median concentration at SC274 and SC273 to reach these milestones.

Table 12. TP concentration reductions necessary to meet TMDL endpoints.

	Current TP Median (mg/L)	Phase I TMDL (mg/L)	Phase I Concentration Reduction (percent)	Phase II TMDL (mg/L)	Phase II Concentration Reduction (percent)
SC274 Cottonwood River	0.396	0.164	58.6%	0.121	69.4%
SC273 Neosho R	0.330	0.164	50.3%	0.121	63.3%

Presuming the first Phase of reducing phosphorus levels in the TMDL watershed improves water quality but does not attain the biological indicators, a second phase of implementation will commence. Stage One will direct further reductions in wastewater phosphorus by Emporia, while Stage Two installs treatment and practices on the tributaries in the TMDL watershed as well as in the upstream contributing watershed. In time, median phosphorus concentrations should approach the median value of the stations within the ecoregion 28 Neosho Basin stations (0.121 mg/L), encompassing all flow conditions.

Achievement of lower phosphorus loading on lower Cottonwood River and the Neosho River will contribute to achieving the TMDL for eutrophication in John Redmond Reservoir, approved on February 27, 2003. The John Redmond TMDL noted that the impairment in the lake is associated with waste treatment plants in the watershed. Therefore, the reduction in phosphorus wasteload from Emporia will additionally benefit John Redmond Lake.

Achievement of the biological endpoints indicates any loads of phosphorus are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: There are 12 permitted NPDES facilities located within the TMDL watershed. The permitted facilities are categorized as follows: one “non-overflowing” lagoon that is prohibited from discharging, seven industrial facilities, two commercial facilities, one municipal facility, and one MS4 stormwater permit. The permitted facilities are detailed in Table 13. All of the facilities are located in the lower Cottonwood TMDL watershed above SC274, with the exception of the Westar Energy Emporia Center which is above SC273 in the TMDL watershed.

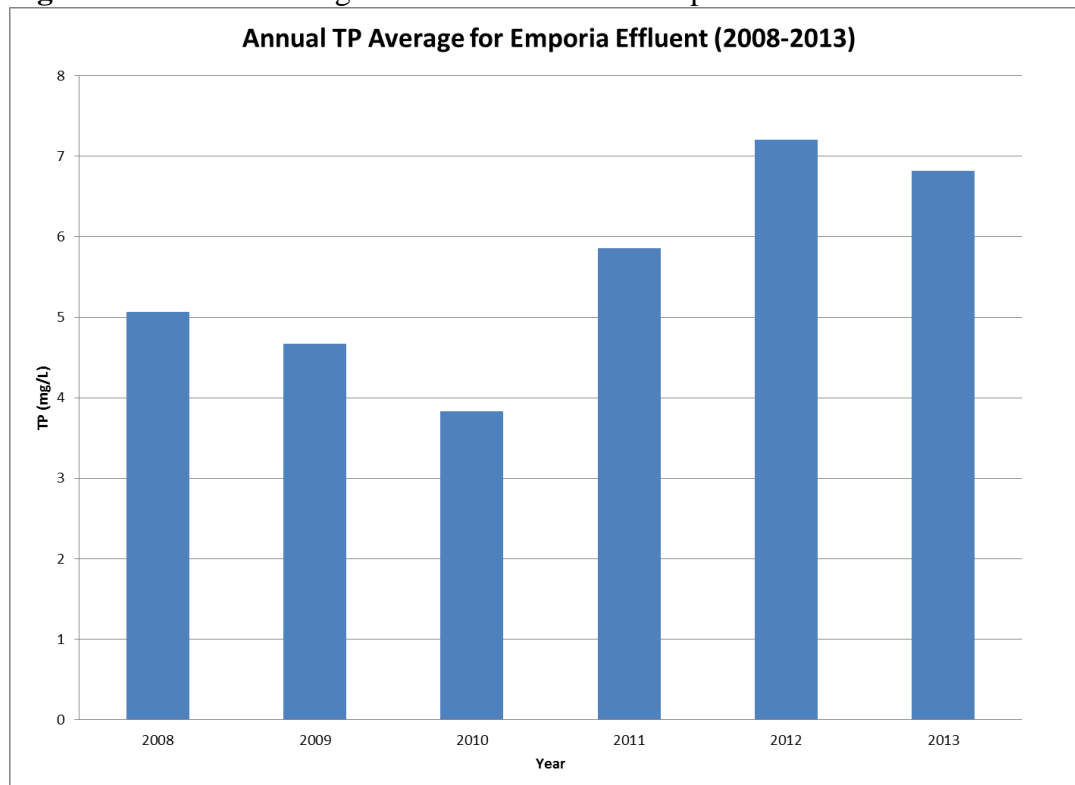
The City of Emporia is the only municipal wastewater treatment plant in the TMDL watershed. Their NPDES permit requires weekly composite sampling for Total Phosphorus and daily flow monitoring of their effluent. The permit states that the permittee will operate the treatment facility to maximize the level of nutrient removal with the goal of achieving Total Phosphorus ≤ 1.0 mg/l as an annual average in their effluent, though this is not a current effluent limit. The TP concentration average for the City of Emporia from 2008-2013 has been 5.94 mg/L, with an average flow of 2.11 MGD over this same period. Nutrient targets are placed into permits to provide goals for the facilities. These goals often facilitate the planning and design of facility upgrades to achieve the capability to meet the targets stated in the permit. The City of Emporia has not met the goals stated in their permit. Therefore assuming operations have maximized the level of nutrient removal, this is an indicator that this facility is in need of upgrades and may consider implementing biological nutrient removal (BNR) to maximize nutrient removal. Annual TP concentration averages in the Emporia effluent are detailed in Figure 21.

Table 13. NPDES permitted facilities in the TMDL watershed.

Permit #	NPDES #	Facility	Type/Comment	Design Flow (MGD)	Receiving Stream	Permit Expires
C-NE24-0003	KS0095729	GREEN ACRES MOBILE HOME PARK	Mechanical, Activated Slud	0.0516	Cottonwood R via Moon Cr via Unamed Trib	10/31/2018
I-NE24-PO02	KS0000817	TYSON FRESH MEATS -EMPORIA MAIN PLT	Mechanical, 8-cell lagoon	0.65 with 2.8 potential	Cottonwood R via Unnamed Trib	12/31/2018
I-NE24-PO06	KS0099244	EMPORIA PWS WATER TREATMENT PLANT	3-cell Lagoon	0.381 to lagoon	Cottonwood R	12/16/2016
I-NE24-CO06	KS0094412	EMPORIA INDUSTRIAL PARK III POND	Mechanical, Waste STBL Po	2.0 to cooling lake	Cottonwood R via Unnamed Trib	9/30/2013
M-NE24-SN01	KSR044005	EMPORIA, CITY OF	Mun Stormwater General R	0.0000	MS4	1/31/2019
M-NE24-IO01	KS0046728	EMPORIA, CITY OF	Mechanical, Activated Slud	4.6000	Cottonwood R	4/30/2018
I-NE24-PO08	KS0099368	WESTAR ENERGY - EMPORIA ENERGY CTR	Process Water, Waste STBL	0.163 to pond	Neosho R via Badger Cr via Coon Cr via Unnamed	1/31/2013
I-NE24-PR01	KSG110163	PENNY'S CONCRETE, INC. - EMPORIA	Concrete Plant, Settling Basin		Cottonwood R	9/30/2017
I-NE24-PR02	KSG110169	BUILDERS CHOICE CONCRETE - EMPORIA	Concrete Plant, Settling Basin		Cottonwood R via Unnamed Trib	9/30/2017
C-NE24-0001	KS0115584	COUNTRY MOBILE HOME PARK	3-cell Lagoon	0.0048	Cottonwood R via Dry Cr via unamed Trib	3/31/2018
I-NE24-BO01	KS0098264	BPE MANUFACTURING	Lagoon, Cooling Water	0.001 avg	Cottonwood R via dry drainage	12/31/2018
C-NE24-NO04	KSJ000552	EMPORIA RV PARK WWTF	Non-Overflowing			4/30/2014

*-highlighted design flows are average flows noted in the industrial permits.

Figure 21. Annual average TP concentration for Emporia Effluent.



The Green Acres Mobile Home Park currently monitors Total Phosphorus once monthly. The current TP concentration average in their effluent is 4.75 mg/L. Discharging flow has not been reported for their effluent flow as stated in the permit. The other commercial facility permit, Country Mobile Home Park, does not require Total Phosphorus monitoring. There are only a couple of discharging events recorded for the Country Mobile Home Park facility. The Emporia RV Park commercial facility has a non-overflowing permit and is not contributing to the total phosphorus impairment in the TMDL watershed since they do not discharge.

The two concrete plants typically do not discharge. The Builders Choice Concrete facility has reported two discharging events and the Penny's concrete facility has not reported any discharge over the reporting period since 2008.

The industrial permit for the Emporia PWS Water Treatment plant has an estimated flow of 0.381 MGD to the lagoon. This permit is for the discharge of the overflow from their wastewater lagoon system, derived from process water. There is no nutrient monitoring associated with this permit as this facility poses no potential to total phosphorus loading in the TMDL watershed.

The Emporia Industrial Park Pond permit has an average flow of 2.0 MGD to the pond. The water discharged is municipal potable water utilized for non-contact cooling. There is no nutrient monitoring associated with this permit as this facility poses no potential for total phosphorus loading in the TMDL watershed.

The BPE Manufacturing facility discharges non-contact cooling water that averages 1000 to 1500 gallons per day. They additionally discharge about 100 gallons per day associated with domestic waste from the facility. Domestic wastewater is routed to a one-cell lagoon. This facility is required to perform monitoring for Total Phosphorus annually. Based on their monitoring results of TP effluent data, there were only two detections out of seven samples. The TP concentration average in their effluent is approximately 0.06 mg/L. Data from this facility confirms there is minimal potential of Total Phosphorus loading to the TMDL watershed associated with their discharge.

The Westar Emporia Energy Center discharges process water into an on-site pond. Monitoring for Total phosphorus is not required in the permit for this facility and this facility has no potential to contribute total phosphorus loading to the TMDL watershed.

The City of Emporia's MS4 permit was re-issued in February of 2014. The MS4 permit follows a general permit format, requiring six minimum controls to be implemented throughout the permitted areas. The new permit will require the implementation of BMPs to address nutrients and sediment during the new permit cycle, along with subsequent high flow monitoring of the Cottonwood and Neosho Rivers to evaluate performance.

The Tyson Fresh Meats facility is a beef processing plant that has historically operated as a complex slaughterhouse. The daily average discharge for their current beef processing

operation is 0.65 MGD according to their permit, but based on their discharge data this facility is not regularly discharging at the present time and has not reported any discharge since 2012. When the facility previously operated as a complex slaughterhouse the average wastewater discharge was 2.8 MGD. Full scale operations have not occurred at this facility since 2007. Based on the monitoring results of the effluent data, their current TP average in their effluent during beef processing is 4.04 mg/L. Historic data associated with the complex slaughterhouse operations indicates the average TP concentration in their effluent was approximately 25 mg/L. Significant operational changes must occur to reduce the TP concentrations associated with the effluent of the complex slaughterhouse operations if these operations were to be reinstated. Since this facility remains permitted to discharge, there is potential for this facility to contribute to the TP impairment in the TMDL watershed.

Livestock and Waste Management Systems: There are six certified or permitted confined animal feeding operations (CAFOs) within the TMDL watershed, none of which are large enough to require a federal permit. All of these livestock facilities have waste management systems designed to minimize runoff entering their operation and detain runoff emanating from their facilities. These facilities are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with streamflow that occurs less than 1-5% of the time. It is unlikely TP loading would be attributable to properly operating permitted facilities, though extensive loading may occur if any of these facilities were in violation and discharged. Table 14 details the facilities within the TMDL watershed.

Table 14. Registered or Permitted Animal Feeding Operations in the watershed.

KS Permit #	County	Animal Total	Permit Type	Animal Type	WLA
A-NELY-B008	Lyon	999	Renewal	Beef	0
1028	Lyon	950	Registration	Beef	0
N-NELY-6921	Lyon	500	Application	Swine	0
A-NELY-BA04	Lyon	250	Certification	Beef	0
A-NELY-T003	Lyon	0	Renewal	Truckwash Commercial	0
A-NELY-B004	Lyon	700	Permit	Beef	0

Though the total potential number of animals is approximately 3,399 head in the TMDL watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number.

According to the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) Kansas Farm Facts 2012 report, there were 61,000 and 38,000 head of cattle (including calves) in Lyon and Chase counties respectively and 3,800 head of hogs reported in Lyon County (hogs not reported for Chase County). The 2007 Census of Agriculture reported there were 2,004 goats and 1,215 horses in Lyon County and 824 horses in Chase County.

On-Site Waste Systems: Households outside of Emporia are presumably utilizing on-site septic systems. Based on the population of Emporia relative to the TMDL watershed population, there are an estimated 6304 people being served by on-site waste systems in the TMDL watershed. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) was utilized to identify the number of septic systems within the HUC12s within the TMDL watershed. According to STEPL, there are approximately 432 septic systems within the TMDL watershed with an anticipated failure rate of 0.93%. Since 80% of the population within the TMDL watershed reside within Emporia and are served by wastewater treatment facilities, failing on-site septic systems do not likely contribute to the total phosphorus impairment within the TMDL watershed.

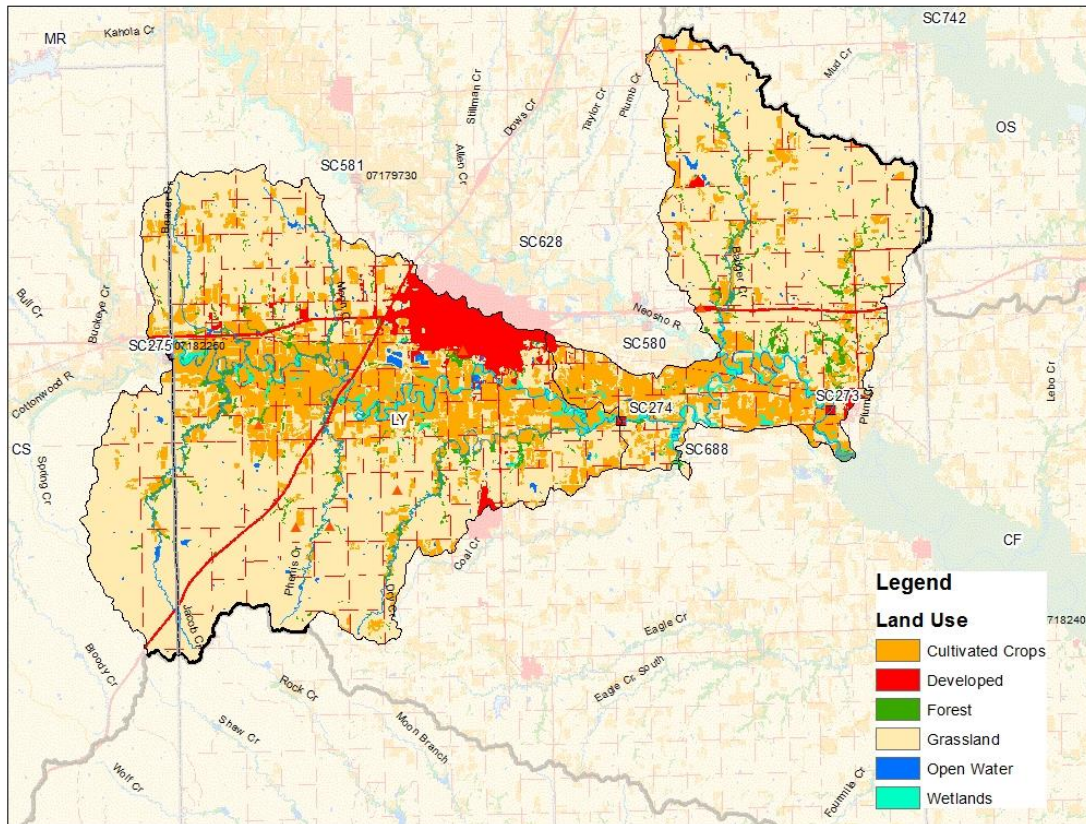
Population Density: According to the 2010 Census Block information, the TMDL watershed has approximately 31,220 people, with a population density of 153.6 people/square mile. There are approximately 24,916 people residing within Emporia. Population changes from the 2000 to 2010 census show that the population of Emporia has declined by 1844 people, accounting for a population decline of 6.9 % over the 10-year period.

Land Use: Land use within the TMDL watershed is dominated by grassland (67.0 %) according to the 2001 National Land Cover Data set (NLCD). Cropland and developed areas comprise about 18.6% and 9.8% of the TMDL watershed respectively. The land use percentages and acres within the TMDL watershed are in Table 15 and are further illustrated in the land use map (Figure 21). Figure 22 illustrates the location of the cropland within the TMDL watershed, which is in the low lying areas adjacent to the stream corridors. Runoff from the cropland draining to and within the TMDL watershed and runoff from developed areas within the TMDL watershed could contribute significant sources of total phosphorus loading.

Table 15. Landuse acres and percentages in the TMDL watershed.

Land Use	Acres	Percent
Grassland	82720	67.0
Cropland	23019	18.6
Developed	10338	8.4
Forest	4307	3.5
Wetlands	1961	1.6
Open Water	1111	0.9

Figure 22. Landuse Map for Lower Cottonwood and Neosho R TMDL watershed.



Contributing Runoff: The TMDL watershed has a mean soil permeability value of 0.35 inches/hour, ranging from 0.01 to 2.24 inches/hour according to the NRCS STATSGO database. About 60% of the TMDL watershed has a permeability value less than 1.14 inches/hour, which contributes to runoff during very low rainfall intensity events. Whereas 99% of the TMDL watershed has a permeability value less than 1.71 inches/hour, which contributes runoff during low rainfall intensity events. According to an USGS open-file report (Juracek, 2000), the threshold soil permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil-permeability. As the TMDL watersheds' soil profiles become saturated, excess overland flow is produced. The majority of the nonpoint source nutrient runoff will be associated with cropland areas throughout the TMDL watershed that are in close proximity to the stream corridors.

Background: Phosphorus is present over the landscape, in the soil profile as well as terrestrial and aquatic biota. Wildlife can contribute phosphorus loadings, particularly if they congregate to a density that exceeds the assimilative capacity of the land or water.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

This TMDL will be established in Phases and Stages to progressively reduce phosphorus loadings and ambient concentrations with periodic assessment of the biological endpoints on the lower reaches of the Cottonwood River and its influence on the water quality in the Neosho River at SC273. The phases and stages of this TMDL are detailed in Table 16. The initial phase will entail reductions in phosphorus levels of the Emporia wastewater that should translate to an instream median concentration approaching the median of the mean TP concentrations for ecoregion 28 Neosho basin stations. TP load reductions will occur throughout the stream and be monitored as SC274 and SC273. Reduced upstream TP loading will be indicative as the TP concentrations approach the TP target concentrations, which will result in favorable biological support throughout the stream. Additionally, riparian management in areas adjacent to cropland and livestock management in the vicinity of streams within the TMDL and upstream watershed should reduce nonpoint source loads under conditions of moderate flows as part of Stage Two.

Once the concentrations at Station SC274 and SC273 approach the Phase One target of a median TP concentration of 0.164 mg/L and sestonic chlorophyll < 5 ug/l, an intensive assessment of macroinvertebrate diversity will be made to determine compliance with the narrative nutrient criteria.

Table 16. TP TMDL Phases, Milestones and Actions.

TMDL Phase / Stage	TP Milestone at SC274 and SC273	Anticipated Action	Biological Endpoints
I – 1 (NPDES)	0.164 mg/l	Emporia WW BNR and Enhance Disposal by Irrigation; Emporia MS4	ALUS Index Score ≥ 14 Sestonic Chlorophyll < 5 $\mu\text{g/l}$ John Redmond Lake Chlorophyll <i>a</i> < 10 $\mu\text{g/l}$
I - 2 (Nonpoint)	0.164 mg/l	Riparian and Livestock Management	
II – 1 (NPDES)	0.121 mg/l	Emporia WW ENR; Emporia MS4	
II – 2 (Nonpoint Source)	0.121 mg/l	Targeted Tributary Riparian Management adjacent to cropland in TMDL and upstream watershed	

Presuming one or more of the biologic endpoints are not met at the end of Phase One, Phase Two will commence. Additional reductions in loads and phosphorus concentrations will be accomplished through enhanced implementation of controls on point and non-point sources. The desired target levels are comparable to the median concentrations seen at the ecoregion 28 Neosho River Basin stations. Emporia wastewater will undergo enhanced nutrient removal and the management of riparian activities will be extended to urban stormwater contributing areas and along tributaries adjacent to cropland throughout the TMDL and upstream watershed. As nonpoint practices are implemented, TP concentrations will be reduced to meet the Phase Two milestone at the unimpaired upstream station of SC275. This will result in achievement of the TMDL for all segments associated with the TP impairment. A second intensive biological assessment will be made once phosphorus levels approach that seen at the regional benchmark of 0.121 mg/L of TP.

The established TMDL is detailed in Figures 23 and 24 relative to the current observed loads at stations SC274 and SC273.

Figure 23. Cottonwood River TMDL at SC274.

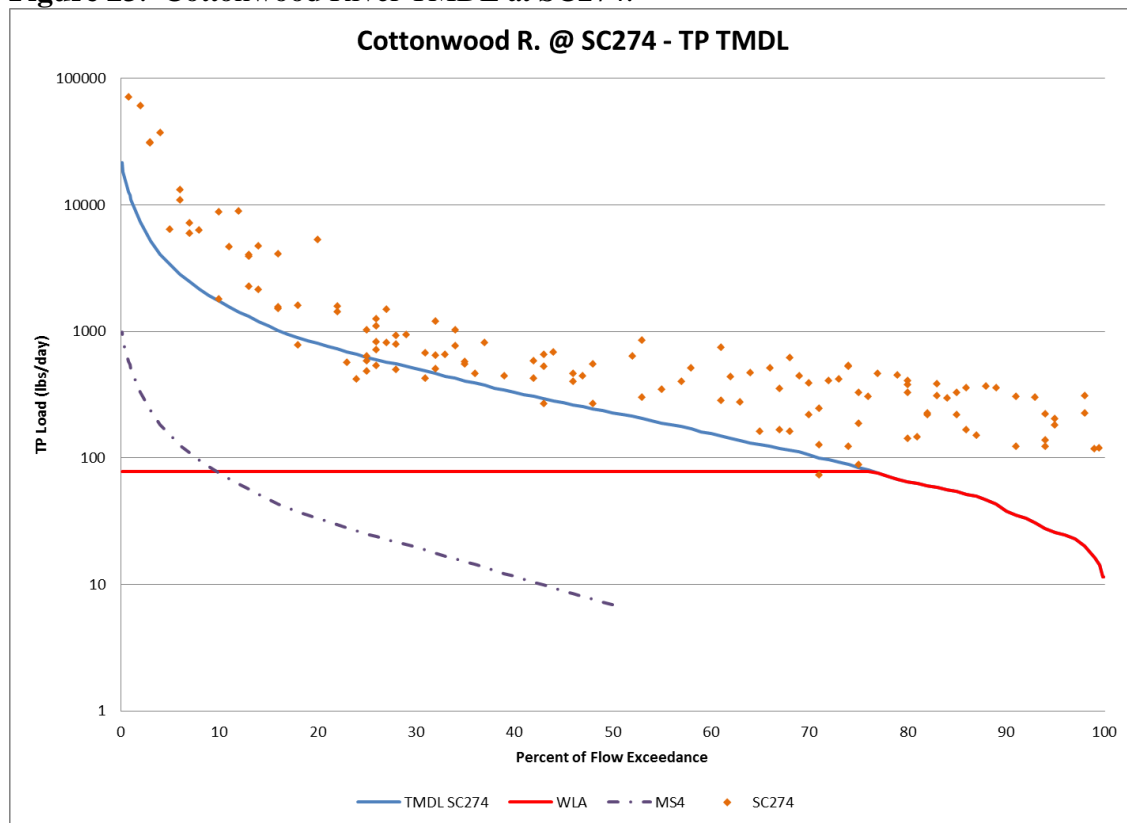
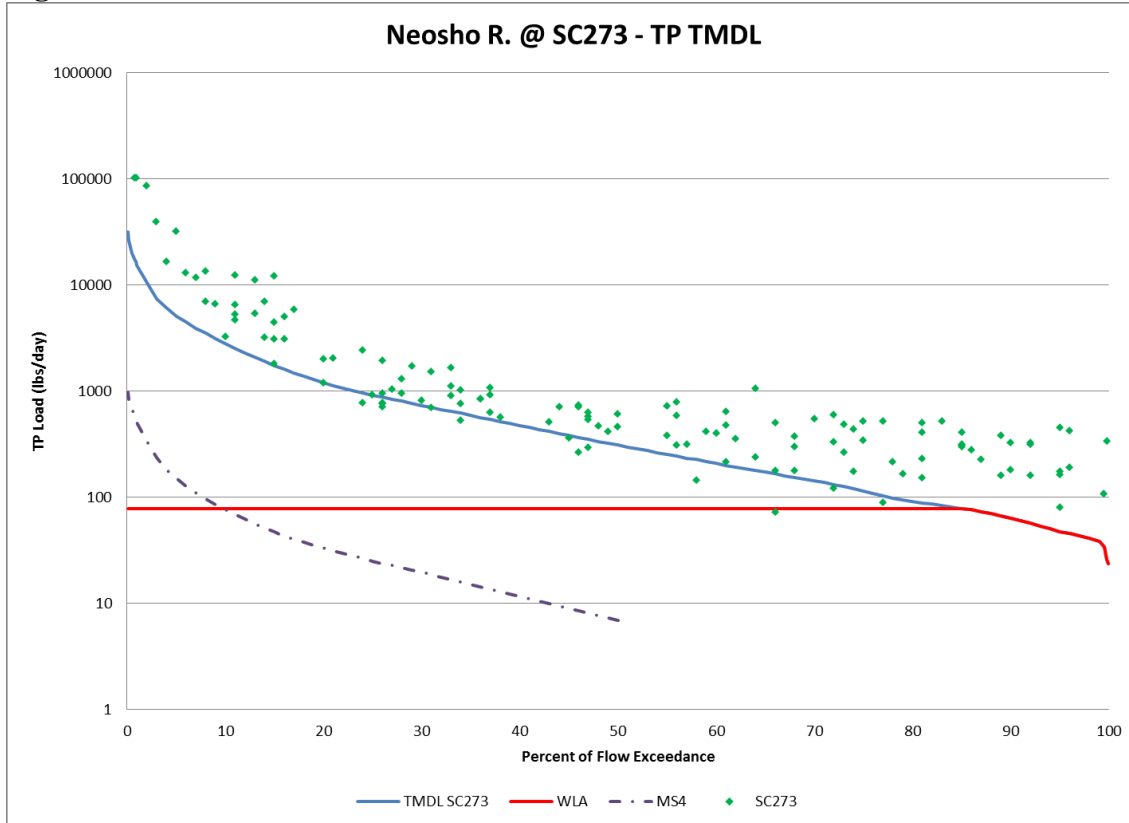


Figure 24. Neosho River TMDL at SC273.



Point Sources: The Wasteload Allocations (WLA) are associated with the wastewater treatment facilities for the City of Emporia, Tyson Fresh Meats, Green Acres Mobile Home Park, Country Mobile Home Park, and BPE Manufacturing. There is an additional WLA reserve being set aside in the TMDL watershed as well to accommodate possible operational changes associated with the Tyson Fresh Meats facility. The WLA for the TMDL watershed is 78.21 lbs/day.

The WLA for these facilities are detailed in Tables 17a and 17b. WLA for the Green Acres Mobile Home Park and the City of Emporia have been established based on their design flow and a discharge TP concentration of 1.5 mg/l. The WLA for Tyson Fresh Meats has been set based on their average flow in the permit (0.65 MGD) for the most recent plant operations, relating to the processing of cut beef. The WLA for the BPE manufacturing is based on their average discharge flow (0.001 MGD) and their current TP concentrations in their effluent. The WLA for the Country Mobile Home Park is based on the design flow (0.0048 MGD) with a discharge concentration of 2.0 mg/l, an effluent TP concentration seen from Kansas lagoon systems. It is not anticipated that wasteloads associated with the BPE Manufacturing and the Country Mobile Home Park will require any load reductions. The WLA reserve is based on the Tyson Fresh Meats facility permit and is based on the average flows (2.8 MGD) if this facility is open for

complex slaughterhouse operations with a discharge TP concentration of 0.5 mg/l utilizing enhanced nutrient reduction technologies.

Use of wastewater for irrigation and efficient operation of the treatment processes at Emporia will assist lowering phosphorus loading and concentrations seen at SC274 and SC273. Prior to initiating Phase Two and Enhanced Nutrient Removal at the City of Emporia, an evaluation should be initiated to consider the growth in current wasteloads among the facilities and the probability of discharge from Tyson Fresh Meats. In addition, consideration of assimilation rates of wastewater phosphorus, wasteload trading opportunities among cities, opportunities to further irrigate with wastewater and actual efficiency in phosphorus removal by the mechanical and lagoon systems should be evaluated, along with resulting downstream total phosphorus concentrations at SC274 and SC273.

Table 17a. Phase I Wasteload Allocations for the TMDL watershed.

Facility	Phase I TP Discharge Concentration (mg/L)	Daily TP WLA (lbs/day)	Annual TP WLA (lbs/year)
GREEN ACRES MOBILE HOME PARK	1.50	0.65	236.16
TYSON FRESH MEATS -EMPORIA MAIN PLT	1.50	8.15	2972.93
EMPORIA, CITY OF	1.50	57.64	21038.97
COUNTRY MOBILE HOME PARK	2.00	0.08	29.20
BPE MANUFACTURING	0.06	0.00	0.37
Reserve	0.50	11.70	4268.68
Total WLA		78.21	28546.29

Table 17b. Phase II Wasteload Allocations for the TMDL watershed.

Facility	Phase II TP Discharge Concentration (mg/l)	Daily TP WLA (lbs/day)	Annual TP WLA (lbs/year)
GREEN ACRES MOBILE HOME PARK	1.50	0.65	236.16
TYSON FRESH MEATS -EMPORIA MAIN PLT	0.50	2.71	989.15
EMPORIA, CITY OF	0.50	19.22	7015.30
COUNTRY MOBILE HOME PARK	2.00	0.08	29.20
BPE MANUFACTURING	0.06	0.00	0.37
Reserve	0.50	11.70	4268.68
Total WLA		34.35	12538.85

Phase Two would commence if biological information indicated the impacts identified in the narrative criterion for nutrients were still occurring after Phase One was complete. Should the Stage II-1 milestone become the new goal, the wasteload allocation for Emporia will be reduced to reflect a typical annual average effluent concentration of 0.5 mg/l from Enhanced Nutrient Removal. In addition, urban best management practices would be installed to reduce loads delivered to the Cottonwood River by stormwater generated within the jurisdictional limits of Emporia under the purview of their MS4 permit.

Actual wasteload allocations attributed to ambient concentrations seen downstream under normal conditions are anticipated to be much less than the allocations of Tables 17a and 17b because of adsorption to sediments and absorption by biota. Tables 18 and 19 detail the TMDL at SC274 on the Cottonwood River and at SC273 on the Neosho River. Under the low flow conditions, wasteloads will be largely reduced through efficient treatment and alternative disposal such as irrigation, so that they match up with the overall Load Capacity. In-stream wasteloads at the low flow condition assimilate, but still account for the majority of the load. It is conservatively assumed that the entire wasteload from all facilities reach SC273 when the load capacity is greater than the WLA set in this TMDL at SC274, since the entire WLA originates above SC274. TP loads entering the watershed relative to the Phase I TMDL are detailed in Figure 25 to illustrate the loads entering the TMDL watershed at KDHE stations SC275 on the Cottonwood River and SC580 on the Neosho River. The TMDL applies to the entire assessment unit, which includes the full stream segment length for those covered under this TMDL as indicated in Section 1.

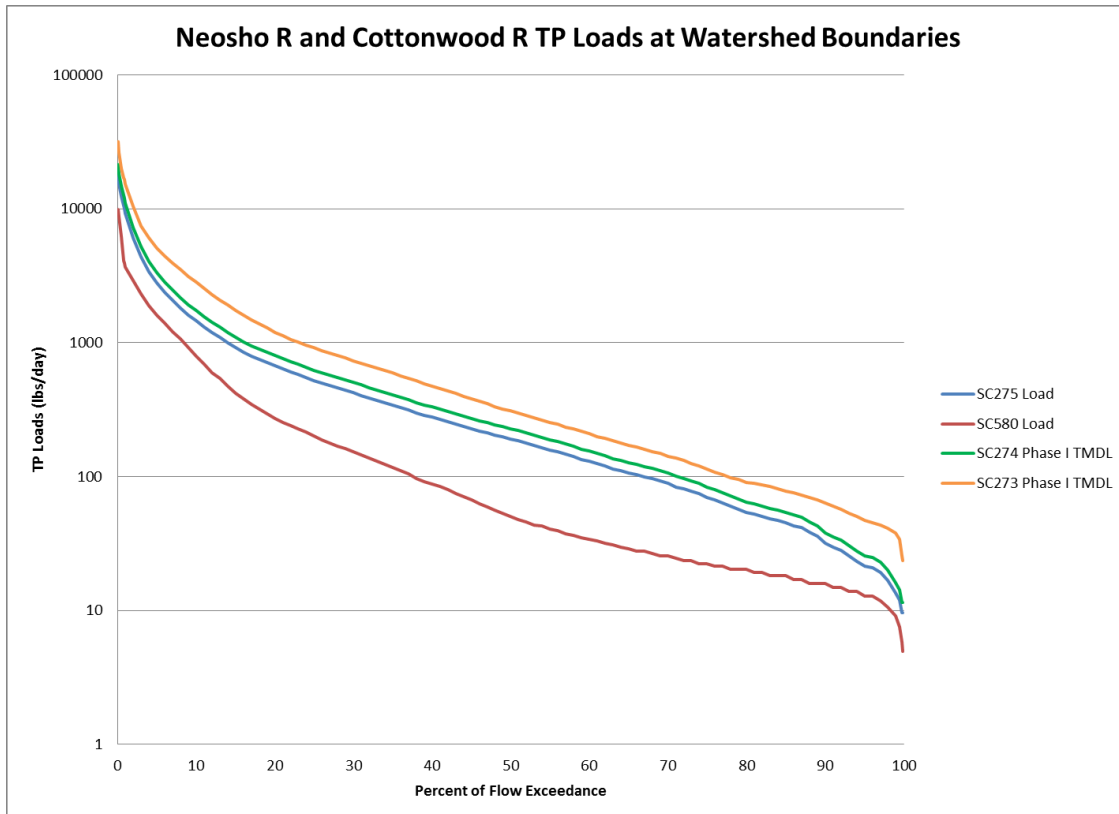
Table 18. Load Capacities and Allocations (lbs/day) under Phase I at SC273 and SC274

<i>Phase I SC273</i>					
<i>Percent Flow</i>	Flow (cfs)	Load Capacity	WLA (lbs/day)	LA (lbs/day)	MS4 Allocation (lbs/day)
90	72.19	63.93	38.15	25.78	
75	128.07	113.42	78.21	35.21	
50	350.45	310.36	78.21	225.26	6.89
25	1035.06	916.65	78.21	813.34	25.10
10	3188.79	2823.99	78.21	2669.53	76.25
<i>Phase I SC274</i>					
<i>Percent Flow</i>	Flow (cfs)	Load Capacity	WLA (lbs/day)	LA (lbs/day)	MS4 Allocation (lbs/day)
90	43.08	38.15	38.15		
75	94.78	83.93	78.21	5.72	
50	257.40	227.95	78.21	142.85	6.89
25	704.36	623.78	78.21	520.47	25.10
10	1960.14	1735.9	78.21	1581.44	76.25

Table 19. Load Capacities and Allocations (lbs/day) under Phase II at SC273 and SC274

<i>Phase II SC273</i>					
<i>Percent Flow</i>	Flow (cfs)	Load Capacity	WLA (lbs/day)	LA (lbs/day)	MS4 Allocation (lbs/day)
90	72.19	47.17	28.15	19.02	
75	128.07	83.68	34.35	49.33	
50	350.45	228.99	34.35	188.48	6.16
25	1035.06	676.31	34.35	622.37	19.59
10	3188.79	2083.55	34.35	1991.87	57.33
<i>Phase II SC274</i>					
<i>Percent Flow</i>	Flow (cfs)	Load Capacity	WLA (lbs/day)	LA (lbs/day)	MS4 Allocation (lbs/day)
90	43.08	28.15	28.15		
75	94.78	61.93	34.35	27.58	
50	257.40	168.19	34.35	127.68	6.16
25	704.36	460.23	34.35	406.29	19.59
10	1960.14	1280.76	34.35	1189.08	57.33

Figure 25. TP loads entering the upper portion of the watershed on the Neosho R and Cottonwood R based on median TP concentrations compared to TP TMDL Phase Loads at SC274 and SC273.



MS4 Stormwater: The Wasteload Allocation for the MS4 stormwater permit associated with the City of Emporia is provided by proportioning the remaining load capacity, after accounting for the NPDES WLA, between MS4 and nonpoint source loads. This was done by assuming load contributions would arise from the developed areas within the HUC12 (110702030405) of the MS4 permitted area for the City of Emporia. Thus, the MS4 WLA is based on the proportion of developed land in the Emporia HUC12, which accounts for 4.6% of the TMDL area. The MS4 allocation is therefore 4.6% of the TMDL, after accounting for the NPDES WLA, and only applies to flows at or above median flow conditions at SC274.

Nonpoint Source Load Allocation: The load allocation for nonpoint sources is the remaining load capacity after assimilated wasteloads for NPDES wastewater and MS4 stormwater have been accounted (Tables 18 and 19). Nonpoint sources are assumed to be very minimal or null at times during low flow and drier conditions when the City of Emporia's effluent is the primary influence on water quality within the lower Cottonwood River. The load allocation grows proportionately as normal conditions occur. The allocation and contributing areas increase as wet weather ensues.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty in phosphorus loading into the TMDL watershed, predominantly from the point source dischargers. This TMDL uses an implicit margin of safety, relying on conservative assumption to be assured that future wasteload allocations will not cause further excursion from the nutrient criteria. First, design flows are used for the municipal wastewater discharge facility to set wasteload allocations, although demographic trends indicate Emporia is likely to decline in population. Additionally, biological endpoints are used to assess the narrative criteria and have to be maintained for three consecutive years before attainment of water quality standards can be claimed. Finally, because there is often a synergistic effect of phosphorus and nitrogen on in-stream biological activity, concurrent efforts by Emporia to reduce nitrogen content of their wastewater should complement the effect of phosphorus load reduction in improving the biological condition of the TMDL watershed.

State Water Plan Implementation Priority: Phase One priority is focused on wastewater treatment at Emporia and riparian management along the stream corridors to effectively reduce the phosphorus loading to the TMDL watershed. Phase Two priorities will expand nonpoint source abatement. Additionally, further reduction in wastewater phosphorus loads at Emporia will occur. Due to the need to reduce the high nutrient loads in the TMDL watershed and the resulting benefits to John Redmond Lake, this TMDL will be High Priority for Implementation.

Nutrient Reduction Framework Priority Reduction Ranking: A portion of this TMDL watershed lies within the Neosho Headwaters Subbasin (HUC8 11070201), which is among the top sixteen HUC8s targeted for state action to reduce nutrients.

Priority HUC12s: Although this TMDL is initially driven by implementation of point source treatment improvements, priority HUC12s within the TMDL watershed can be identified based on the cropland areas adjacent to the streams. All of the HUC12s associated with this TMDL contain priority areas. Nonpoint source reduction efforts are further prioritized to the areas of the riparian corridors on the main stem of the Cottonwood River or Neosho River adjacent to cropland or livestock facilities.

5. IMPLEMENTATION

Desired Implementation Activities:

1. Implement and maintain conservation farming, including conservation tilling, contour farming, and no-till farming to reduce runoff and cropland erosion.
2. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips along the stream and drainage channels in the watershed.
3. Perform extensive soil testing to ensure excess phosphorus is not applied.
4. Ensure land applied manure is being properly managed and is not susceptible to runoff by implementing nutrient management plans.
5. Install pasture management practices, including proper stock density to reduce soil erosion and storm runoff.

6. Ensure proper on-site waste system operations in proximity to the main stream segments.
7. Ensure that labeled application rates of chemical fertilizers are being followed and implement runoff control measures.
8. Make operational changes in wastewater treatment at Emporia and alternative disposal such as irrigation and, if necessary, install enhanced nutrient reduction technology to reduce wasteloads.
9. Renew state and federal permits and inspect permitted facilities for permit compliance.
10. Facilitate urban stormwater management in Emporia to abate pollutant loads.
11. The stakeholder leadership team for the Cottonwood watershed WRAPS and Neosho Headwaters WRAPS will coordinate BMPs to address:
 - a. Livestock: vegetative filter strips, relocate feeding sites, relocate pasture feeding sites off-stream and alternate watering system.
 - b. Cropland: waterways, terraces, conservation crop rotations and water retention structures.

NPDES and State Permits – KDHE

- a. Monitor influent into and effluent from the discharging permitted wastewater treatment facilities, continue to encourage wastewater reuse and irrigation disposal and ensure compliance and proper operation to control phosphorous levels in wastewater discharges.
- b. Establish applicable permit limits and conditions after 2018.
- c. Inspect permitted livestock facilities to ensure compliance.
- d. New livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
- e. New registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.
- f. Manure management plans will be implemented, to include proper land application rates and practices that will prevent runoff of applied manure.
- g. Reduce runoff in Emporia through stormwater management program and MS4 permit.
- h. Establish TP concentration effluent goal of 1.5 mg/l for the City of Emporia and TP permit limits for the City of Emporia in accordance with the WLA.
- i. Establish nutrient reduction practices among urban homeowners to manage application on lawns and gardens, through the Emporia stormwater management program.
- j. Interact with WRAPS on opportunities for trading and offsets of loads between Emporia and agricultural producers within the watershed.

Nonpoint Source Pollution Technical Assistance – KDHE

- a. Support Section 319 implementation projects for reduction of phosphorus runoff from agricultural activities as well as nutrient management.
- b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.

- c. Provide technical assistance on nutrient management for livestock facilities in the watershed and practices geared toward small livestock operations, which minimize impacts to stream resources.
- d. Support the implementation efforts of the Cottonwood and Neosho Headwaters WRAPS and incorporate long-term objectives of this TMDL into their 9-element watershed plan.
- e. Engage the City of Emporia to discuss stormwater load trading opportunities.

Water Resource Cost Share and Nonpoint Source Pollution Control Program-KDA-DOC

- a. Apply conservation farming practices and/or erosion control structures, including no-till, terraces, and contours, sediment control basins, and constructed wetlands.
- b. Provide sediment control practices to minimize erosion and sediment transport from cropland and grassland in the watershed.
- c. Install livestock waste management systems for manure storage.
- d. Implement manure management plans.

Riparian Protection Program – KDA-DOC

- a. Establish or re-establish natural riparian systems, including vegetative filter strips and streambank vegetation.
- b. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
- c. Promote wetland construction to reduce runoff and assimilate sediment loadings.
- d. Coordinate riparian management within the watershed and develop riparian restoration projects.

Buffer Initiative Program – KDA-DOC

- a. Install grass buffer strips near streams.
- b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance – Kansas State University

- a. Educate agricultural producers on sediment, nutrient, and pasture management.
- b. Educate livestock producers on livestock waste management, land applied manure applications, and nutrient management planning.
- c. Provide technical assistance on livestock waste management systems and nutrient management planning.
- d. Provide technical assistance on buffer strip design and minimizing cropland runoff.
- e. Encourage annual soil testing to determine capacity of field to hold phosphorus.

- f. Educate resident, landowners, and watershed stakeholders about nonpoint source pollution.
- g. Promote and utilize the WRAPS efforts for pollution prevention, runoff control and resource management. The WRAPS coordinator is also an extension watershed specialist that will provide technical assistance and outreach to producers for BMP implementation. Other entities for this task include NRCS and local conservation districts.

Timeframe for Implementation: Reduction strategies for Emporia wastewater should be evaluated by mid-2015 with subsequent planning, design, and construction of any necessary enhance treatment completed within the next permit cycle after 2018. Urban stormwater and rural runoff management should commence in Emporia during 2015. Pollutant reduction practices should be installed within the priority subwatersheds before 2017, with follow-up implementation over 2018-2022. If biological conditions warrant, Phase Two will begin in 2028 and continue through 2038.

Targeted Participants: The primary participants for implementation will be the City of Emporia wastewater and stormwater programs, and agricultural and livestock producers operating immediately adjacent to the main stems of the Cottonwood and Neosho Rivers. Watershed coordinators and technical staff of the WRAPS, along with Conservation District personnel and county extension agents should assess possible sources adjacent to streams. Implementation activities to address nonpoint sources should focus on those areas with the greatest potential to impact nutrient concentrations adjacent to these creeks.

Targeted Activities to focus attention toward include:

1. Overused grazing land adjacent to the streams.
2. Sites where drainage runs through or adjacent to livestock areas.
3. Sites where livestock have full access to the stream as a primary water supply.
4. Poor riparian area and denuded riparian vegetation along the stream.
5. Unbuffered cropland adjacent to the stream.
6. Conservation compliance on highly erodible areas.
7. Total row crop acreage and gully locations.
8. High-density urban and residential development in proximity to streams and tributary areas.
9. Residents of Emporia should be informed on fertilizer and waste management through the Emporia Stormwater Management Program to reduce urban runoff loads.

Milestone for 2022: In accordance with the TMDL development schedule for the State of Kansas, the year 2022 marks the next review of the 303(d) activities in the Neosho Basin. At that point in time, phosphorus data from SC274 and SC273 should show indications of declining concentrations relative to the pre-2014 data, particularly during normal flow conditions. By 2022, the City of Emporia should be fully implementing the appropriate measures to decrease the phosphorus content of its wastewaters.

Delivery Agents: The primary delivery agents for program participation will be the City of Emporia, KDHE, the Cottonwood Watershed WRAPS, and the Neosho Headwaters WRAPS.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution:

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the water of the state.
2. K.S.A. 65-117d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
3. K.S.A. 2002 Supp. 82a-2001 identifies the classes of recreation use and defines impairment for streams.
4. K.A.R. 28-16-69 through 71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.
5. K.S.A. 2-1915 empowers the Kansas Department of Agriculture, Division of Conservation to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.
6. K.S.A. 75-5657 empowers the Kansas Department of Agriculture, Division of Conservation to provide financial assistance for local project work plans developed to control nonpoint source pollution.
7. K.S.A. 82a-901, et. seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.
8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the Kansas Water Plan, including selected Watershed Restoration and Protection Strategies.
9. The Kansas Water Plan and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority implementation.

Funding: The State Water Plan annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction

activities in the state through the Kansas Water Plan. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watershed and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are located within a High Priority WRAPS area and should receive support for pollution abatement practices that lower the loading of sediment and nutrients.

Effectiveness: Use of Biological Nutrient Removal technology has been well established to reduce nutrient levels in wastewater, including phosphorus. Additionally, nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. In addition, the proper implementation of comprehensive livestock waste management plans has proven effective at reducing nutrient runoff associated with livestock facilities.

6. MONITORING

Future stream sampling will continue to occur quarterly at sampling stations SC274 and SC273. The monitoring will include the continuation of sestonic chlorophyll sampling at SC274. Monitoring of tributary levels of TP during runoff events will help direct abatement efforts toward major nonpoint sources. Monitoring of TP below the Emporia outfall in the Cottonwood River will help assess improvements in their nutrient removal processes. Monitoring of TP should be a condition of the MS4 permits within the TMDL watershed. Monitor chlorophyll *a* concentrations in John Redmond Lake.

Commencing in 2017, macroinvertebrate sampling will occur at accessible locations on the Cottonwood and Neosho Rivers within the TMDL watershed. The streams will be evaluated for possible delisting after Phase One implementation in 2024. If the biological endpoints are achieved over 2019-2023, the conditions described by the narrative nutrient criteria will be viewed as attained and the Lower Cottonwood River at SC274 and the Neosho River at SC273 will be moved to Category 2 on the 2024-303(d) list. If they are not, Phase Two of this TMDL begins in 2028.

Once the water quality standards are attained, the adjusted ambient phosphorus concentrations on the Cottonwood and Neosho Rivers will be the basis for establishing numeric phosphorus criteria through the triennial water quality standards process to protect the restored biological and chemical integrity of the rivers.

7. FEEDBACK

Public Notice: An active Internet Web site is established at http://www.kdheks.gov/tmdl/planning_mgmt.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin. This TMDL was posted to this site on August 7, 2014 for public review.

Public Hearing: A public Hearing on this TMDL was held on August 28, 2014 in Emporia to receive public comments. No comments were received.

Basin Advisory Committee: The Neosho River Basin Advisory Committee met to discuss the TMDLs in the basin on March 6, 2014 in Marion.

Milestone Evaluation: In 2022, evaluation will be made as to the degree of implementation that occurred within the TMDL watershed. Subsequent decisions will be made through the WRAPS, regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The lower Cottonwood at SC274 and the Neosho River at SC273 will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2015-2023. Therefore, the decision for delisting will come about in the preparation of the 2024-303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision would come in 2015, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS plan. Recommendations for this TMDL will be considered in the *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2015-2023.

May 27, 2015

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